DEC 8 1923 Medical Lib.

OFFICIAL JOURNAL OF THE AMERICAN COLLEGE OF SURGEONS

ANNUAL SUBSCRIPTION: UNITED STATES AND CANADA, $12.00; FOREIGN, $14.00.

Volume XXXVII DECEMBER, 1923 Number 6

Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

EDITORIAL STAFF

FOR AMERICAN COLLEGE OF SURGEONS

William J. Mayo, M.D.

Albert J. Ochsner, M.D. John M. T. Finney, M.D.

George W. Crile, M.D. Harvey Cushing, M.D. J. Bentley Squier, M.D.

George E. de Schweinitz, M.D. John L. Porter, M.D. T. J. Watkins, M.D.

E. Wyllys Andrews, M.D. Frederic A. Besley, M.D. W. R. Cubbins, M.D.

George E. Armstrong, M.D. Rudolph Matas, M.D.

FOR THE BRITISH EMPIRE

Sir Arthur Mayo-Robson, K.B.E., C.B., C.V.O., D.Sc.

Sir Berkeley Moynihan, K.C.M.G., C.B. J. Rutherford Morison, M.B., F.R.C.S.

Sir Harold J. Stiles, K.B.E., F.R.C.S. (Edin.) Thomas W. Eden, M.D., F.R.C.S.

Sir William de C. Wheeler, M.D., F.R.C.S.I.

Franklin H. Martin, M.D., Managing Editor

Allen B. Kanavel, M.D., Associate Editor

EDITORIAL AND BUSINESS OFFICES: 30 N. Michigan Ave., Chicago, Illinois, U. S. A.

PUBLISHERS FOR GREAT BRITAIN: Bailliere, Tindall & Cox, 8 Henrietta St., Covent Garden, London, W. C., England

Bickham's Operative Surgery

IN SIX VOLUMES, TOTALING 5400 PAGES WITH 6375 ILLUSTRATIONS

SAUNDERS, *Publishers* SEE PAGE 13

Entered as second-class matter May 22, 1913, at the postoffice at Chicago, Ill., under the Act of Congress, March 3, 1879.
Published monthly. Copyright, 1923, by The Surgical Publishing Company of Chicago.

EVERY SURGEON NEEDS IT

BRADY'S POTTER-BUCKY DIAPHRAGM

No surgeon should operate without the best information on internal conditions that can be secured only when a Potter-Bucky Diaphragm is used in the X-Ray Laboratory. You should insist on your X-Ray man at least TRYING one to assure himself and yourself of the truth of this.

Gives especially fine detail on heavy parts such as spine, kidney, gall-bladder, pelvis, etc., impossible to secure in any other way. THE GREATEST AID TO FINE RADIOGRAPHY EVER PRODUCED. The smallest, neatest and most accurate Bucky made.

New model with many improvements, price $250.00, less 10 per cent cash discount for prompt payment. Try it and be convinced.

EVERYTHING IN X-RAY SUPPLIES

We carry a large stock of all X-Ray supplies, including Duplitized Films, Plates, Intensifying Screens, Developer, Dental Film Mounts, Developing Tanks, Coolidge Tubes, etc. Get our Price List and Discount before buying. Prompt shipment, always.

GEO. W. BRADY & CO., 756 So. Western Ave., Chicago, Ill.

RADIUM

STANDARD CHEMICAL CO.

"Know the Company from Which You Buy"

Dependability—Service

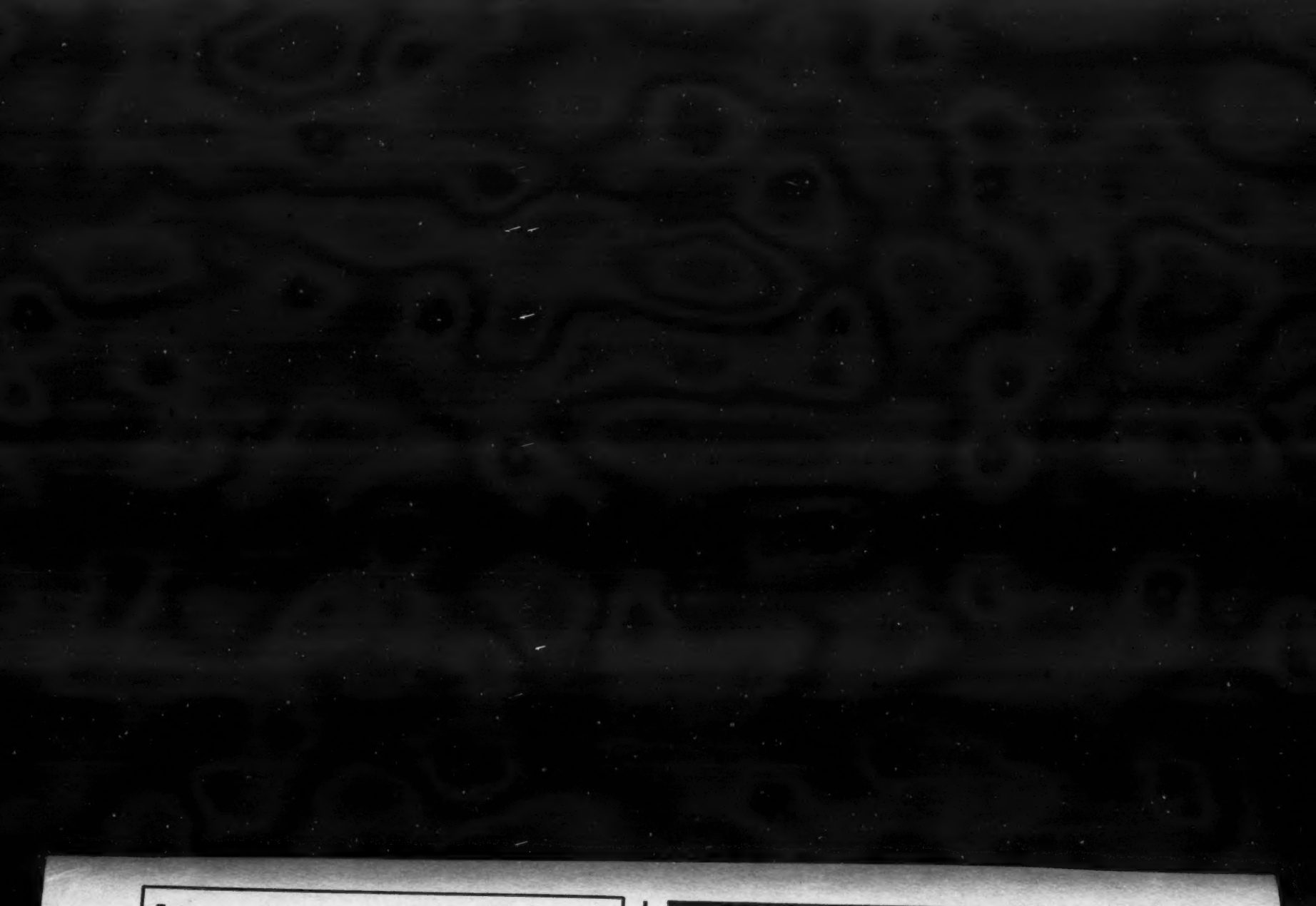
THE character of service rendered by the Radium Chemical Company is typical of the Company's standing and long leadership in the industry.

Our service includes, among other things, a comprehensive and scientific course of instruction in the physics and the therapeutic use of radium. And our medical and technical experts are always available for conference, or for advice by letter.

RADIUM CHEMICAL CO.

PITTSBURGH, PA.

BOSTON NEW YORK CHICAGO SAN FRANCISCO DALLAS



SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XXXVII DECEMBER, 1923 NUMBER 6

PEDICULATED POLYPOID FIBRO-ADENOMA OF THE STOMACH OF BALL-VALVE TYPE, CAUSING AN UNUSUAL AND COMPLEX SYNDROME

PERIODIC CRISES OF INTENSE EPIGASTRIC PAIN, WITH SHOCK, VOMITING, MELÆNA (TARRY STOOLS) AND PROFOUND SECONDARY ANÆMIA; TRANSFUSION; COMPLETE RELIEF AND RECOVERY FOLLOWING EXTIRPATION OF TUMOR BY GASTROTOMY; A CLINICAL REPORT, WITH DISCUSSION [1]

BY RUDOLPH MATAS, M.D., F.A.C.S., NEW ORLEANS

Professor of Surgery, Tulane University of Louisiana School of Medicine

CLINICAL history.[2] Mr. W. F. M., age 55, farmer, native of Mississippi, has resided in the country all his life. There is nothing in his heredity or in his personal history of any importance as related to his present condition. He has always been a hard-working farmer, enjoying excellent health and well able to keep up with any of the men in the field.

His present trouble began rather suddenly, 16 months ago. He had worked hard on a very hot day and perspired freely. "He relaxed after the day's work was over and took no precaution against taking cold." The next morning he felt pain in the chest, especially in the left costal margin, on breathing. He paid no serious attention to the pain at the time, but the pain became so much worse that a doctor had to be summoned, who told him that he had pleurisy. He had some fever at that time. In a few days he was well and went back to work. While in the field, 2 weeks later, he suddenly fainted. He was taken home and remained in bed for 4 days, growing weaker daily and losing his appetite gradually. At the end of 4 days he "picked up" and began to recover. The following week saw him out on the farm again. Some weeks later a third attack came. This time he had violent pain in the epigastrium, followed by complete collapse. Again he became profoundly weak, lost his appetite, and had slight temperature and excessive perspiration at night. He was treated this time for pulmonary tuberculosis. He recovered after a time sufficiently to work again on the farm, when a fourth attack came in the form of a sudden and sharp pain in the pit of the stomach, with nausea and vomiting. During this spell he had a number of loose stools of a tar-like color. He was then advised to have a roentgen-ray examination. In the interim between this attack and his admission to the infirmary he had several of these "up-and-down spells," each one coming closer, lasting longer, and disabling him more than the preceding one. *During an attack he was always seized by an acute violent pain in the epigastrium, accompanied by shock and a sense of persistent depression, faintness, pallor, with nausea and vomiting of gastric contents (no blood), followed soon after by the passage of dark, tarry stools. The attacks were of variable duration and intensity, and lasted from a few minutes to a few hours.* These spells would cease spontaneously, but more often required morphine and other sedatives to quiet him. After the crises, he would pick up, gain strength, look better and feel inclined to work, but each succeeding attack left a deeper impression on his strength and a greater pallor. The pain in the epigastrium was an invariable accompaniment of an attack. Nausea, vomiting, and loose, tarry stools were not always present.

By the advice of his physician he came to New Orleans and consulted Dr. John B. Elliott, who admitted him to the Touro Infirmary on January 11, 1922. After careful examination and repeated radiographic sittings, he concluded that the patient had an ulcer at the pylorus, whether or not malig-

[2] Abridged from the records of Touro Infirmary, by Dr. J. Cohen, interne.

[1] Read in abstract at the meeting of the Southern Surgical Association, Memphis, Tennessee, December, 1922

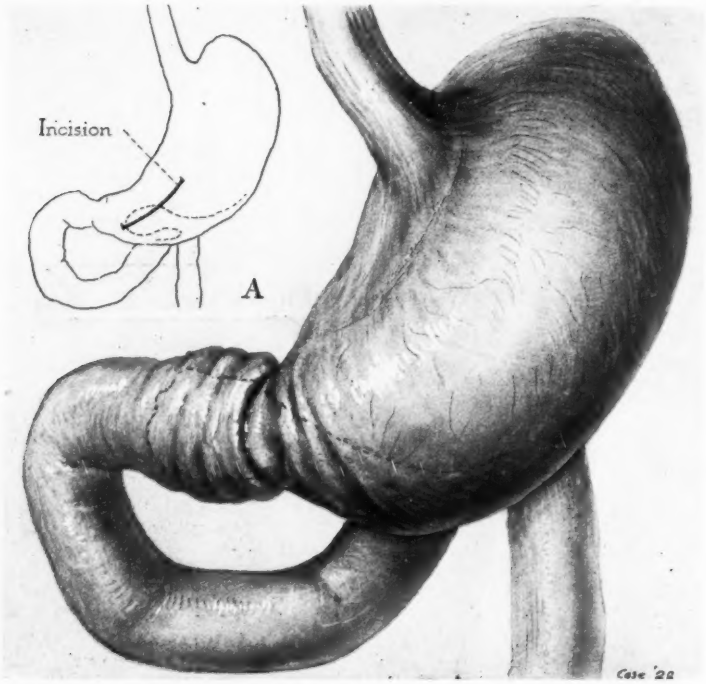


Fig. 1. Pedunculated polypoid fibro-adenoma of the stomach. Insert, *A*, shows the normal position of the growth in the quiescent stage; the larger drawing, *B*, the growth impacted in the pylorus and upper duodenum, causing invagination of the stomach into the duodenum, (Matas.)

nant he could not tell, but advised that the patient be operated upon promptly "as the only chance he had for his life." He returned home on his discharge from the infirmary on January 13, 1922. Having had another severe attack in the meantime, he returned to the hospital on January 17, 1922, and applied to Dr. Matas for surgical relief.

Condition on admission, January 17, 1922. The picture of a tall, powerful man, 6 feet 2 inches, normally weighing 185 pounds, now a physical wreck from the effects of malnutrition, emaciation, and pain; he is strikingly anæmic and totters from weakness. The lips and tongue are dry and the skin warm; the teeth are neglected and the breath foul. Except for the persistent weakness and loss of flesh, with the complaint of a gnawing pain localized in the epigastrium and radiating to the back, the physical examination of the patient is largely negative. The abdomen is retracted, scaphoidal, and no tumor can be palpated in the epigastrium or anywhere in the abdomen. The attacks of pain that he complains of have no relation to the time of eating, quality, or quantity, of food. They come independently of the meals. On admission the pulse is 100; blood pressure: systolic 124, diastolic 58; pulse pressure 66; temperature 100 degrees. The urine showed a trace of albumin with a few granular and hyaline casts. Blood: total red count 1,762,000; hæmoglobin 30 per cent; color index 88; total white count 4050; differential: small 20; large 4; neutrophiles 75; eosinophiles 1; anisocytosis; poikilocytosis. The gastric analysis showed a hyperchlorhydria, *no blood*. The fæces show occult blood in every examination. The radiographic laboratory (January 13, 1922), among other less important details, reports: "There is a marked deformity about the pylorus and stomach. A serial radiographic examination following the second barium meal showed a large filling defect about the pylorus, probably due to an extensive ulcer of beginning malignancy. The stomach emptied readily and is empty entirely at the end of 6 hours. Conclusions: *Saddle ulcer, probably malignant.*" (See roentgenograms.)

In the light of the operative findings it is easier to interpret the roentgenograms of the pylorus, but, even with all of the knowledge obtained through the operation, it is evident that the correct diagnosis could not have been made by the roentgenogram alone.

The patient was admitted in a period of calm. He then could eat and drink with seeming impunity, but, he had no appetite. However, in order to prepare him for the operation, he was put on a milk diet, with eggs, gelatin, and thin cereals, at regular intervals, and a Murphy drip instituted, containing glucose 5 per cent, panopepton, calcium chloride, and gelatin to counteract the hæmorrhages. Digalen (minims 10) with morphine (⅛ gr.) and atropine were given by needle nightly.

Transfusion. January 19, on the third day after admission, 400 cubic centimeters of citrated blood obtained from the patient's son were transfused by Dr. Lucian H. Landry. No immediate notable effect followed except a febrile reaction, 101 degrees F., the next day, and continued with remissions to the third day after transfusion. There has always been an underlying febrile movement since his admission, with a daily variation of 1 degree above and below the normal line. The blood pressure rose 20 points and the blood picture improved only a little. The benefit from this transfusion appears to have been transitory. The absence of pain and vomiting and tarry stools seems to have improved the patient. On January 20, 3 days after admission, the patient was brought to the operating room, only to be sent back after careful deliberation with the anæsthetist, Dr. Caine, as too great a risk and unfit to undergo any serious operation. The diastolic blood pressure then was barely 58 and the hæmoglobin a little over 30 per cent.

Again systematic feeding was resumed and a daily record of blood pressure and of the character of stools was kept. For 2 weeks this was continued, although the blood pressure scarcely arose over 65 diastolic, and the hæmoglobin to 45 per cent. Nevertheless, the freedom from pain and apparent cessation of intestinal hæmorrhage contributed to the improvement of the patient. As he improved, he became restless and impatient for operation.

Operation. (Notes dictated by Dr. Matas.) This was performed, February 3, 1922, 16 days after the patient's admission to the infirmary. Under gas-oxygen anæsthesia (Dr. Caine) the abdomen was opened by epigastric incision, right rectus, a little to the right of the mid line. The exploring hand of the operator at once palpated the pylorus, which was thickened and enlarged, giving the impression that it was the seat of a neoplasm which involved the whole pyloric contour on the gastric and duodenal sides of the pyloric ring. A mass seemed to block the pyloric ring and project into the duodenum. *While attempting to exteriorize the pylorus for further inspection, the manipulations dislodged the mass "en bloc," and, to our surprise, this retreated completely within the stomach, leaving the pyloric ring free but without the slightest evidence of infiltration or thickening of any sort.* It seemed then that there was a foreign body of soft consistency, the nature of which we could not determine, but which, by blocking the pylorus, acted as a ball valve, accounting in this way, at least, for the periodicity of the attacks.

Fig. 2. Appearance of tumor on opening the stomach after it had retracted from the pylorus (semidiagrammatic). Drawing should show the duodenum more dilated. *A*, Sketch of tumor with part of attached pedicle. (Matas.)

Taking every precaution to prevent the spilling of the gastric contents, and in order to control the movements of the mass (which had migrated far up in the gastric cavity, requiring considerable manipulation to recover and hold it in place), the stomach was clamped above and below the tumor with a pair of thin Doyen forceps. After the stomach had been exteriorized above the level of the pyloric antrum it was opened right over the mass, immediately above the pyloric antrum, by an incision, 2 inches in length, running parallel with the long axis of the stomach and lying midway between the lesser and greater curvature (Fig. 1). Through this incision the mass was recognized as a pediculated gastric tumor, which, as previously stated, was attached to and grew from the mucosa on a level with the greater curvature and about 5 to 6 inches above the pylorus. The tumor had an attachment to the mucous membrane about 3 centimeters in width at its base, tapering into a narrow neck about 1 centimeter in width at its attachment to the tumor. The tumor was therefore extremely movable, but it projected into

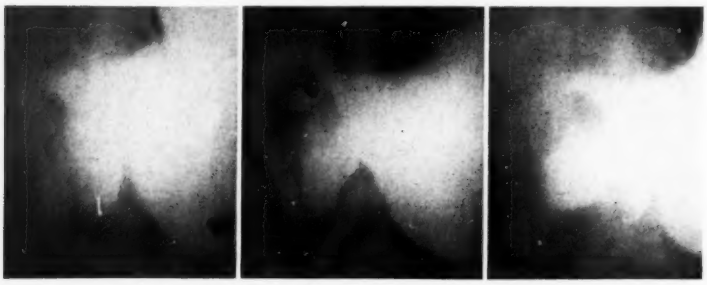


Fig. 3. Case of W. F. M. Polypoid pediculated adenoma of the stomach of the ball-valve type. Series of roentgenograms taken immediately after the ingestion of the opaque meal. They show a large and striking filling defect in the pylorus and duodenum which is dilated at the pyloric junction and thrown into folds by the invagination of the tumor with its attached pedicle. The exposures were made during the period of calm, in the interval between the gastric crises, caused by pylorospasm with strangulation of the tumor and of the invaginated gastric mucosa. (Reproduced by courtesy of the Roentgenologic Laboratory of the Touro Infirmary.)

the interior of the stomach like a mushroom (Figs. 1 and 2), without ulceration, fungosity, or any raw surface whatever. It was merely a growth from the mucosa which rested on a mobile base, freely movable, on the submucous and muscular layers. In consequence of the mobility of its base of attachment the tumor can be easily exteriorized through the incision and its base clamped and crushed with a Payr angiotribe. After this the mass was amputated and the raw surface left on the mucosa was sutured over with continuous silk. This completed the hæmostasis and sealed the raw surface left by the excision of the tumor. The incision into the stomach wall was also closed with continuous silk suture for the mucosa and double Lembert for the peritoneum and muscular coats. Before closing, the stomach, pylorus, and first part of the duodenum were again palpated and inspected from within, but no signs of ulceration could be detected, only a marked dilatation of the first part of the duodenum, which could be accounted for by the presence of the tumor, which acted not only as a ball valve, blocking the pylorus, but was probably accompanied by an intussusception of the gastric mucosa into the duodenum as the stomach tried vainly to squeeze and rid itself of the tumor. Before closing the abdomen the gall bladder was palpated and found to be perfectly normal, free from calculi and emptying readily on pressure. It was also noticed in replacing the stomach and great omentum that there were several enlarged lymph nodes on the gastro-epiploic arch. Nothing further was done except to close the abdominal incision in the usual way, with deep interrupted separate silkworm sutures and the rest of the wound was closed in tiers, with catgut. The specimen was immediately transferred to the pathologist, Dr. Lanford, whose report is appended.

A Jutte duodenal tube was left in the stomach, projecting through the nose for the purpose of draining the gastric contents which might accumulate in the stomach by regurgitation from the duodenum through a widely dilated pylorus, and, also, to act as a flue or ventilator to allow the continued escape of gases.

The recovery of the patient was uneventful in spite of his weakened condition, and when discharged, February 22, 1922, the abdominal wound was completely healed. On the day before his departure the urine still showed a faint trace of albumin but no casts; the stools were negative for occult blood; the blood pressure, 132–88; the total red cell count was 2,585,000; hæmoglobin 45 per cent; color index 0.9; total white cells 5150; differential: small 8; large 3; neutrophiles 89; anisocytosis; poikilocytosis less marked.[1]

Pathologist's report. "The specimen is a mushroom-shaped structure with edges somewhat irregular. In its longest diameter it measures 6 centimeters and other measurements in the same plane are 4.5 and 2 centimeters. At its widest portion it measures 5 centimeters and its thickness varies from 1.5 to 2 centimeters. The upper surface is somewhat uneven but velvety in consistency, and of a pinkish-yellow color, relatively uniform throughout. The under surface is of the same general appearance, except that the attached mucosa is relatively loose and gives an impression of being stretched and pediculated by the growth. The under surface also presents a relatively large raw area, in the central portion of which is a firm, fibrous mass or pedicle. The consistency is firm, with the density of the gastric mucosa, but it is uniform throughout. On section it offers little resistance to the knife and presents a cut surface resembling the cut surface of the gastric mucosa, that is, a thick layer of pinkish-gray color, soft and supported by a denser tissue of connective-tissue type. In the upper layer, which is relatively

[1] It is now 1 year and 6 months (June 1, 1923) since this patient was operated upon, and his reports up to the present time confirm his complete recovery. He has continued to work on his farm without interruption or sign of relapse.

uniform, are noted a few minute spaces filled with mucous material. Gross diagnosis is mucous polypus.

"*Diagnosis.* Adenoma. Histologically benign. Section shows glandular acini of various sizes and shapes, some of which are filled and to a degree distended with fluid. The epithelium is for the most part high columnar and adult in type. The stroma is largely smooth muscle."

This observation is instructive in many ways, but its chief interest lies in its diagnostic teachings. Here we have a clear-cut, well-defined, symptomatic picture and a clinical history which, together with the roentgenologic findings, leads to almost certain pre-operative conclusions, yet, nevertheless, contradicted by the operative findings. Here we learn that a perfectly benign polypoid or pediculated non-vascular tumor may cause paroxysmal gastric crises characterized by the most intense epigastric pain with vomiting and extreme exhaustion verging on actual collapse. That these crises are accompanied and followed by black, tarry stools (melæna), which by frequent repetition led to a progressive and profound secondary anæmia, reaching a low hæmoglobin ebb of 30 per cent, and a red cell count of less than 1,750,000. In addition, the radiologic image as seen in series through the screen, and by radiograph, distinctly suggest the presence of a tumor which fills the pylorus, causing obstruction and pylorospasm. While the roentgenograms, when looked at in the light of the operative findings, are susceptible of a different interpretation than that which was suggested by the pre-operative image, the presumption that the filling defect in the pylorus and duodenum was caused by a malignant growth seemed *then* to be in harmony with the general conclusions arrived at by the clinician.

With such a syndrome and clinical history before us, it is not surprising that a correct pre-operative diagnosis should have been missed in this, as in nearly all the cases of this type, thus far reported, in spite of the roentgenological examination. Is it surprising that, in the vast majority, the diagnosis of malignant tumor or ulcer of the pylorus, with spasm, saddle ulcer, or duodenal ulcer, should have been the predicated diagnosis? Or, again, when there is no occult blood in the fæces nor melanotic stools, the acute paroxysmal pain in the epigastrium should have been interpreted often as a gall-stone colic, the real cause—a benign pediculated and mobile tumor prolapsed into the duodenum—only coming to light in the course of the exploration? This then is the usual error—the classic error—which has been constantly repeated until very recent times.

On the other hand, the pain, vomiting, and pyloric obstruction (filling defect revealed by the roentgen-rays), and the periodicity of these gastric crises followed by periods of calm, during which there were practically no digestive disturbances, are all signs and symptoms which, when looked at *a posteriori*, are strikingly suggestive of a mobile, intermittent pathology not in consonance with the continuously progressive history of gastric carcinoma. A different interpretation of the roentgenographs and of the symptomatology in this case would, no doubt, have been suggested if only the clinical behavior of the polypoid or pediculated benign tumors of the stomach had been more clearly impressed on the minds of the several observers, and the differential diagnosis had not been influenced by the estimate of probabilities in favor of malignant tumor. We can readily understand the mechanism by which these periodic crises are produced by the traction exercised on the extensible base of the tumor after it has been ejected through the pylorus into the duodenum. Similar cases which exhibit the sequence of pyloric obstruction, strangulation, and invagination of the gastric mucosa have already appeared in the literature and are strikingly illustrated in the observations reported by Chiari (6), 1888 (quoted by Ledderhose); Lotsch (16); Wade (23); Bland-Sutton (4); and more recently by Baylac and Dieulafé (3) (invagination in non-pediculated gastric tumors), in which the real pathology was only brought to light by the operative findings.

But the presence of blood in the fæces and the black, tarry stools, sufficient to cause a profound secondary anæmia, as in this case, is not so easily accounted for by the presence of a simple benign polypus and is truly confusing to the clinician. A cursory survey of the recent and growing literature of polypoid adeno-

mata in particular and of the benign tumors of the stomach in general (of which the pediculated tumors form a very considerable part) shows that bleeding, sufficient to cause a severe anæmia—though rarely as grave as in this case—is a frequent accompaniment of these growths whether they be of an intrinsically vascular type (hæmangiomata, myoma) or non-vascular (fibroma, fibromyoma, or adenoma type). Thus, in a recent study of 27 benign tumors of the stomach observed and operated upon at the Mayo Clinic, according to Eusterman and Senty (7), recurrent intestinal hæmorrhage was observed as a notable complication in fully 37 per cent of the cases. These observers account for these hæmorrhages chiefly by ulceration or erosion of a part of the tumor. But in the present instance the tumor was free from ulceration, erosion, or varicosities of any kind. In fact, the tumor showed relatively little vascularity. Even admitting a temporary intussusception of the mucosa of the stomach with partial strangulation during the attacks, it is difficult to conceive of such profuse oozing as to cause tarry stools (which brought about a state of collapse at the end of each one of the gastric crises) as the result of mere obstructive congestion and strangulation without ulceration.

Of the benign pediculated tumors of the stomach the myomata are notoriously most liable to progressive hæmorrhage, behaving in this respect somewhat like the polypoid myomata of the uterus or the submucous fibromyomata of this organ. The gravity of the gastrorrhagias from this source is well shown by Farr and Glenn (8), who in writing of the myomata of the stomach report a case terminating fatally by hæmorrhage. That the intestinal hæmorrhages were caused in our case by the presence of the tumor (a simple fibro-adenoma) cannot be doubted, since the bleeding was completely and permanenty arrested with the cessation of the crises after the tumor was removed.

The repeated attacks of pain, the hæmorrhages, exhaustion, occurring at frequent intervals, and loss of weight, continued to direct the attention of the clinician to the more common and vastly more frequent occurrence of malignant disease of the stomach as the more probable diagnosis. This probability was seemingly confirmed by the roentgenologic findings, and all these facts combined tended to deviate the observer's thoughts from the rare benign tumors, whether pediculated or sessile, which are coupled only in a vague hypothetic way with such grave manifestations as were displayed in this case. *It is the failure to realize that a benign and especially a pediculated tumor in the stomach may assume a very malignant aspect ending in death—that is largely responsible for the little attention that is given to these tumors in scanning the differential diagnosis.* The fact that benign tumors of the stomach are statistically rare as compared with the malignant have made them a negligible factor in the estimate of probabilities in cases clouded with obscure or contradictory evidence. Eusterman and Senty, previously quoted, reported a total of 27 benign tumors of the stomach observed in the Mayo Clinic between 1907 and 1921. "During this period operation had been performed on 2,146 patients with cancer of the stomach, on 20 with sarcoma, and on 2 with malignant polypus of the stomach, a total of 2,168. The proportion, therefore, of malignant new-growths to benign new-growths is 78 to 1, i.e., 1.3 per cent of all gastric tumors are benign. But this proportion in our experience is only relative, for, during the same period, 2,285 additional cases of malignant gastric neoplasms, the majority of them inoperable, passed through the clinic." The actua' proportion of benign new-growths to the malignant new-growths or ulcerations they estimate to be 1 to 200.

While the relative infrequency of the benign tumors of the stomach shown by these and other statistics is fully recognized, the surgeon should not be too hasty in attributing to cancer all the manifestations of the advanced gastropathies in which intermittent or periodic epigastric pain, tumor, vomiting, intestinal hæmorrhage, and anæmia, with radiologic evidence of pyloric stenosis and spasm, play a prominent part.

In all cases a thorough sifting of the clinical evidence, especially the occurrence of gastric crises at periodic intervals, after which the stomach enters into a stage of calm, should suggest a most careful and repeated study of

the roentgenologic image with the view of differentiating the polypoid or pediculated tumors which offer more distinctive characteristics and are more frequently benign and operable. That a *pre-operative* diagnosis of these polypoid or other benign growths, especially if pediculated, is possible with the aid of the improved roentgen-ray technique of the present day, is shown by the case reports and contributions of Myer (18; 1913), Stoner (22; 1914), and Basch (2; 1916), Carman (5; 1918), Balfour (1; 1919), and Eusterman and Senty (7; 1922) of the Mayo Clinic; Holmes (12; 1919) of Detroit (pediculated malignant growths); Pendergrass and Pancoast (20; 1920); Ruggles (21; 1920); Merrill (17; 1921), and others in this country. Differential pre-operative diagnoses based on the radiological evidence are reported in the foreign literature by Heinz (11; 1911), Konjetzny (13; 1919–1920), Geymueller (10; 1919), Gassmann (9; 1921), Lieblein (15; 1921), Paus (19; 1908), of Christiania, Ledderhose (14; 1913), and others. While these observers have recorded diagnoses that were more tentative than positive, they are in several instances stated by the roentgenologist independently and in opposition to the clinical diagnosis, showing that in each instance there were reasons derived from the appearance of the roentgenograms to justify a doubt as to the diagnosis of malignant disease in favor of a benign tumor, especially when these were polypoid or pediculated. Gassmann, who has recently (1921) written more specifically upon the roentgen diagnosis of gastric polypi, states that "the fact that a pediculated polypus of the stomach can be diagnosed radiologically is not without practical significance. In some cases operation for carcinoma of the stomach prolongs life, but in the majority of instances it shortens it. If the case which he (Gassmann) reports had been diagnosed as carcinoma he would have hesitated to operate. When it was decided that the growth was probably a polypus it was clear that an operation was necessary to prevent death from bleeding." The operative findings confirmed the roentgen-ray diagnosis and the patient recovered. Eusterman and Senty are right when they state: "Often patients with benign gastric tumors are refused operation because the condition is regarded as malignant and inoperable. The true nature of the lesion is only discovered when the patients insist on operation." *The one salient fact that comes out of this discussion and that is to be retained by the surgeon in approaching a surgical gastropathy is that the most perfect clinical picture of cancer of the stomach may be imitated even to a fatal issue by a perfectly operable benign growth.*

The low mortality and excellent surgical end-results obtained by extirpation of benign polypoid tumors, which are reported by nearly all observers, would justify at least an exploration in doubtful cases, even in the seemingly desperate and forbidding circumstances related in this case.

SUPPLEMENTARY ADDENDUM

The term "polypoid adenoma" is applied in this observation in a qualifying sense to mean simply a pedunculated tumor. Pediculation or pedunculation is an anatomical peculiarity which is common to many tumors. In the gastro-intestinal tract, this mode of attachment may be exhibited by nearly all the benign tumors, such as the lipomata, fibromata, myomata, fibromyomata, lymphangiomata, hæmangiomata, etc., and also, but rarely, by the malignant tumors which may grow on a primarily benign pediculated tumor or develop secondary mobile attachments. At one time, before the histological differentiation of tumors had made as much progress as it has today, all pendulous tumors attached to, or hanging from, mucous surfaces were described as mucous polypi; but at present the term is restricted to the pediculated tumors of a specific histological type, namely, the *adenomata*, when the growth imitates the glandular epithelium of the gastric mucosa, and to the *papillomata*, or mucous warts, which imitates and reproduces the normal surface epithelium.

In this instance we are using the term polypoid in a broad, generic sense to indicate a benign, movable tumor attached by a stem, stalk, or movable base to the surface of the gastro-intestinal mucosa. I lay stress on this point, as I believe that the pediculation of a tumor of the stomach gives it a distinctive clinical and diagnostic physiognomy which

differentiates the polypoid or pediculated tumors as a class, from the sessile or non-pediculated growths which are more often malignant.

When gastric tumors are pediculated they are mobile and the range of excursion varies with the length of the pedicle and the mobility of the base of attachment, some pedicles measuring only a few millimeters and others 12 centimeters or more in length. The base of attachment is also movable according to the nature of the growth and of the surface to which it is attached; the attached mucosa may slide freely on its submucous and muscular layers, yielding readily to traction and thus increasing the length of the pedicle to a very great extent, as in this instance and in many other cases. In some instances the whole wall of the stomach may be dimpled, inverted, or invaginated at the point of attachment of the pedicle, provided sufficient traction is exercised by the tumor. It is in virtue of this traction on the pedicle of polypoid tumors that intestinal obstruction occurs so frequently from invagination and intussusception. Where a tumor of the stomach is pediculated it is easy to conceive the mechanism by which it may cause sudden attacks of pyloric obstruction of a paroxysmal character with pylorospasm and pain of great intensity which may subside, to be followed by variable periods of calm. A pediculated, mobile tumor attached to the mucosa will act as a foreign body which the stomach will endeavor to eject through the pylorus. It will act in this way as a *ball valve* which will obstruct the pyloric ring or block the duodenum. The tumor itself may be large enough to block the pylorus or duodenum, but even a relatively small tumor may, by traction exercised by its pedicle on the gastric mucosa, drag this into and beyond the pyloric ring, thus not only completely obstructing it but favoring partial invagination of the stomach into the duodenum, thereby giving rise to the symptoms of strangulation as well as of obstruction.

This would constitute the *crisis*, or attack, in which, as in this patient's case, intense, agonizing pain in the epigastrium, with vomiting and collapse, followed by tarry stools and progressive anæmia, were the outstanding symptoms. When the pyloric and duodenal spasm relaxes, the symptoms subside and the patient enters into a period of calm which will vary in duration according to many circumstances. The tumor may be released from the pyloric grasp and retract into the stomach, where it may continue to roll about. Or it may lie quiescent in the relaxed duodenum, as in this case, until the continued effort at propulsion may drag the attached mucosa to the pylorus, there to undergo a repetition of the same herniation and strangulation. It is important to remember that these attacks may recur at *irregular* intervals regardless of the meal time or the quantity or quality of food.

The paroxysmal or intermittent character of these attacks, in which the period of violent suffering and collapse is followed by a stage of complete or relative calm, is a striking feature which is eminently suggestive of a "ball valve" pediculated tumor even when "occult blood" and tarry stools (melæna) with progressive anæmia add a graver cast to the clinical picture.

To direct the attention of surgeons to the nature and periodicity of these crises and their diagnostic significance from the clinical point of view is the main purpose of this paper. To synthesize the radiologic observations which have already accumulated in the literature of the last few years in a way that would stamp the distinctive features of the polypoid (pediculated) from the non-pediculated tumors and to separate the benign from the malignant, is indeed a worthy task which, however, I can only touch upon in this brief communication.

[NOTE.—No attempt has been made in this discussion to treat *pediculated gastric adenomata* systematically. The literature is now rich in monographic essays which have steadily accumulated since the classic paper of Brissaud (1885) and Menetrier (1888). Nor has any attention been given here to the rarest but most interesting type of multiple polyadenomatous polyposis *en nappe* or in plaques —which presents very distinct differential clinical and roentgenological characteristics. No mention has been made of a number of solitary pediculated polypi of the ball-valve type, which have been recognized at operation and successfully removed, as in the cases reported by Doyen (1895), C. L. Gibson (1907), J. A. Blake (1907), E. Novak (1920), N. Rankin (1921), and others, which are almost counterparts of the present case in the anatomical, patho-

logical, and operative details, but which differ very notably from the present instance in the lack of the grave clinical syndrome herein described.]

BIBLIOGRAPHY

1. Balfour, D. C. Polyposis of the stomach. Surg., Gynec. & Obst., 1919, xxviii, 465–467.
2. Basch, S. Primary benign growths of the stomach. Surg., Gynec. & Obst., 1916, xxii, 165–170.
3. Baylac and Dieulafe. Invagination de l'estomac et obstruction du pylore par une tumeur de la grosse tuberosité. Bull. et mém. Soc. de chir. de Par., 1918, xliv, 1027–1030.
4. Bland-Sutton, Sir J. On fibroids, lipomata, dermoids and polypi of the stomach and intestine. Lancet, Lond., 1920, ii, 5–9.
5. Carman. See Balfour, and Eusterman and Senty.
6. Chiari. Quoted by Ledderhose.
7. Eusterman, D. B., and Senty, E. G. Benign tumors of the stomach. Surg., Gynec. & Obst., 1922, xxxiv, 5–15.
8. Farr, C. B., and Glenn, R. A. Myomata of the stomach, with report of a case terminating fatally by hæmorrhage. New York M. J., 1913, xcvii, 1351–1354.
9. Gassmann, F. Roentgenologic diagnosis of gastric polyp. Arch. f. Verdauungskr., Berlin, 1912, xxviii, 226.
10. Geymueller. Quoted by Konjetzny.
11. Heinz, H. Ueber Polyposis des Magens. Cor.-Bl. f. schweiz. Aertze, Basel, 1912, xlii, 354; Beitr. z. klin. Chir., Tuebingen, 1914, xciii, 228–250.
12. Holmes, G. W. Pedunculated malignant growths of the stomach. Am. J. Roentgenol., 1919, vi, 279.
13. Konjetzny, G. E. Ueber Magenfibrome. Beitr. z. klin. Chir., Tuebingen, 1920, cxix, 53–61.
14. Ledderhose, G. Ueber Magenpolypen. Deutsche med. Wchnschr., 1913, xxxix, 2349.
15. Lieblein. Fibrom des Magens. Med. Klin., Berl., 1921, xvii, 1583.
16. Lotsch. Invagination eines Pylorusmyoms. Deutsche med. Wchnschr., 1912, xxxviii, 1164.
17. Merrill, A. S. Benign growths of the stomach. Boston M. & S. J., 1921, clxxxiv, 181–183.
18. Myer, J. S. Polyposis gastrica (poly-adenoma). J. Am. M. Ass., lxi, 1960–1965.
19. Paus, M. X-rays as help for the timely diagnosis of stomach tumors. Tidsskr. f. d. norske Lægefor., Christiania, 1908, xxviii, 638–642.
20. Pendergrass, E. P., and Pancoast, H. K. A case of pedunculated adenocarcinoma of the stomach and possible errors in diagnosis. Am. J. Roentgenol., New York, 1920, vii, 602–608.
21. Ruggles, H. E. Unusual gastric polyp. Am. J. Roentgenol., New York, 1920, vii, 356.
22. Stoner, W. C. Polypoid adenoma of the stomach. Ohio M. J., 1914, x, 747–749.
23. Wade, H. Intussusception of the stomach and duodenum due to a gastric polypus. Surg., Gynec. & Obst., 1913, xvii, 184–190.

SUBPERIOSTEAL RESECTION OF LONG BONES IN OSTEOMYELITIS

An Analysis of This Method of Treatment with a Report of 5 Cases

By HOWARD L. BEYE, M.D., Iowa City, Iowa
From the Department of Surgery, State University of Iowa, College of Medicine

SUBPERIOSTEAL removal of the shafts of bones which are more or less extensively involved by infection is a surgical procedure which has found a definite place in the treatment of diaphyseal osteomyelitis, as discussed in the standard textbooks on surgery. It is based on the principle that resection of the diseased portion of the shaft will remove the grossly infected bone, and that osteogenesis will take place from the periosteum to the development of a substantial new shaft.

Nichols[1] advocates the use of this method in subacute osteomyelitis when an accessory bone is present to act as a splint and maintain the length of the limb during the process of regeneration, such as in involvement of the tibia. He states that subperiosteal resection is indicated in cases in which there has been an extensive destruction of the entire diameter of the diaphysis over a greater or less extent. In his opinion if such a necrotic shaft is not removed it will persist as a sequestrum indefinitely, periosteal involucrum will form, and, if the sequestrum is removed later, the involucrum will not fill up the central cavity. He admits that the optimum time for the operation is not easy to determine, but that it averages about the eighth week after the acute infection has been stopped by the evacuation of pus. The results obtained he says, as far as function and use go, are *usually absolutely perfect*, and even in cases where the epiphysis is interfered with, the shortening may be slight and the function perfect. In osteomyelitis of those bones in which no accessory bone is present, he advises waiting until a sufficient involucrum has developed for support, and then the sequestrum is removed.

Warbasse[2] recommends subperiosteal resection for osteomyelitis of the tibia. He advises against its use in the femur and humerus, although he says that it may be used in certain cases and the limb maintained in proper position by the same form of splinting that would be used in the treatment of a fracture of the same bone. He prefers the establishment of free drainage of the necrotic diaphysis, the latter acting as a splint until the involucrum is sufficiently strong.

Stiles[3] discusses the operation of subperiosteal resection for "tuberculous osteomyelitis of the diaphysis." From his description of the various bones operated upon and the X-ray illustrations, it is quite evident that the bone involvement which he discusses, in most of the cases at least, was pyogenic osteomyelitis and not tuberculosis. He used the method in practically all of the long bones. His results are not specifically tabulated. He reports excellent results in many cases, but he mentions incomplete and limitation of bone regeneration, and deformities from bowing and shortening. His discussion of the subject is not convincing.

Some of the sources of failure in this operation are suggested by the three writers to whose articles reference has been made. There are three fundamental errors involved in the procedure of subperiosteal resection of the shaft of bone for osteomyelitis.

In the first place it is impossible to determine accurately, at the time when it is advised that the operation be performed, just what portion of the involved bone is necrotic.

It has been the common experience of any surgeon who has studied a considerable group of pyogenic bone infections, to note that bone which at an early period in the disease seems to be lifeless, may, upon the institution of proper drainage, not only not sequestrate but take a very active part in the process of repair. Until a line of demarcation is established between living and necrotic bone—gross evidence of sequestration—it is presumptive to

[1] Keen's Surgery, vol. ii.
[2] Keen's Surgery, vols. v and viii.
[3] Oxford Surgery, vol. ii, pp. 121–175.

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Fig. 1. Case 1. Six weeks following partial subperiosteal resection of the tibia.

Fig. 2. Case 1. Ten and one-half months after resection. There is a gap in which no bone is being formed. In the 9 months' interval since the roentgenogram shown in Figure 1 was taken, neither tibial fragment has increased appreciably in length. The lower fragment has become displaced upward in its relation to the fibula.

Fig. 3. Case 1. Anteroposterior roentgenogram of both legs taken 6 years following bone transplant. The re-formed tibia is much shorter and there is some rotation of the articular surface in the ankle joint.

Fig. 4. Case 1. Lateral roentgenogram views of both legs taken six years following bone transplant. Note the increased size of the fibula on the affected side.

remove a large segment of infected bone on the assumption that it is doomed.

If the periosteum is still attached to infected bone, that in itself is presumptive evidence that the bone is living. If the periosteum is separated from the cortex to circumscribe the shaft completely—a very unusual condition—then, in all probability, that portion of the diaphysis will become necrotic and eventually sequestrate. But even in this case necrosis may not be the end-result, if adequate drainage is established.

The extent of medullary involvement is no index of necrosis of the enveloping cortical bone. The medullary cavity may contain frank pus from one end to the other and yet complete healing occur without sequestration after the infection has been properly drained.

Necrotic bone on the other hand may serve a very definite purpose in a given case, granted that drainage into the infected bone is well provided for. It acts as a support to maintain a proper length for the extremity and to prevent angulation, bending, and pathological fracture, and it also stimulates osteogenesis from the living bone elements. In certain cases it seems to act as a scaffolding upon which and into which new bone grows. When sequestration has taken place then the separated bone acts only as a foreign body.

The second fundamental error in the operation of subperiosteal resection is to assume that regeneration will take place adequately from the remaining periosteum following resection. In stripping the periosteum from the cortex the most actively osteogenic portion of the whole bone may be left on the shaft and removed with it. Furthermore the technical procedure itself interferes with that portion of the blood supply of the periosteum received through the haversian system from the medullary cavity, and in some cases the freshly ex-

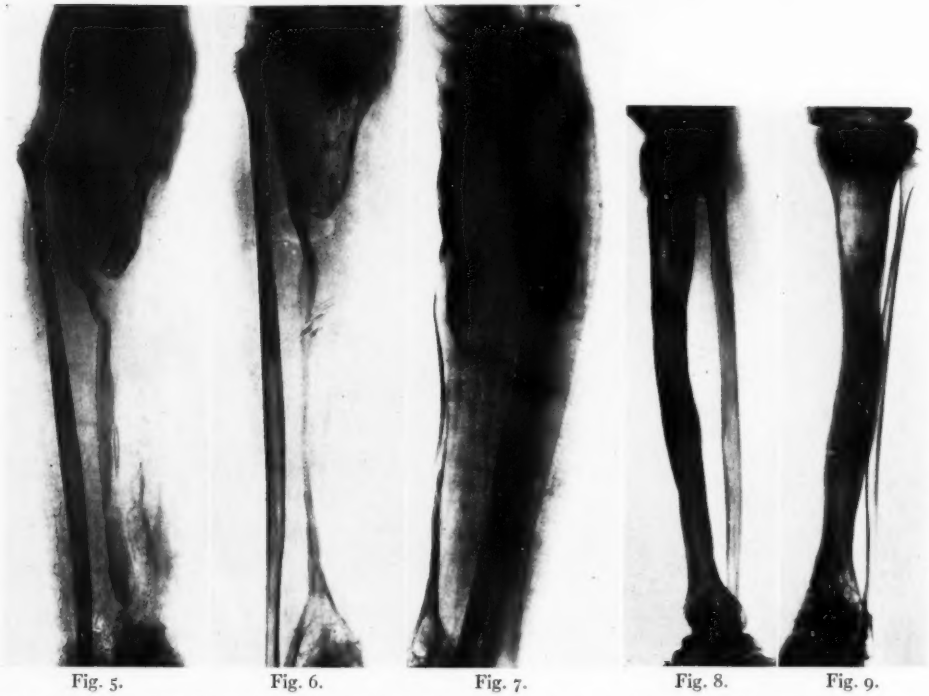


Fig. 5. Fig. 6. Fig. 7. Fig. 8. Fig. 9.

Fig. 5. Case 2. Extent of osteogenesis from the periosteum 9 months following subperiosteal resection of the tibia.

Fig. 6. Case 2. Extent of periosteal osteogenesis 2 years and 3 months following subperiosteal resection. Compare with Figure 5 and note how much new bone has been absorbed during the 18 months' interval. Also during this period the upper tibial stump has increased less than an inch in length. The gross defect between the upper and lower tibial stumps has increased about an inch, due to the growth of the fibula.

Fig. 7. Case 2. Lateral view of the leg to show the amount of re-formation of the tibia 2 years and 3 months following subperiosteal resection.

Figs. 8 and 9. Case 2. Result nearly 3 years after massive bone transplantation from the opposite tibia.

posed, bleeding, inner surface of the stripped periosteum becomes infected at the time of operation. All or any of these factors may inhibit the bone-producing activity of the periosteum — even though it had laid down a fairly substantial involucrum up to the time of operation.

This inhibition, if marked, may determine the complete absence of regeneration over a variable extent of the resected shaft. In other cases regeneration will be begun from the periosteum across the entire defect, but will stop far short of the amount necessary to reform a new shaft. Regeneration may reach a point of maximum amount and then absorption of some of the newly formed bone take place. It seems that this is, in certain measure, due to the lack of functional stimulation incident to the absence of the supporting shaft.

The third fundamental error in this operation is that the procedure is very likely to be followed by deformity. In the cases in which regeneration of bone is complete and rapid, and the resected bone is splinted by a neighboring bone, the deformity may be practically nil. In cases in which a long period of time elapses until a new shaft has developed, very definite shortening of the re-formed bone may take place.

In an actively growing child this may be due to retardation of growth of epiphyseal bone. Such limitation may be caused by operative injury to the epiphyses in total diaphyseal resections, or it may be due to a lack of

normal or functional stimulation of the epiphyses incident to the absence of the supporting shaft over a prolonged period.

In cases in which cast or brace support supplements the support of an adjacent bone and the patient is allowed to bear weight upon the extremity, an actual foreshortening of the resected bone may take place during the process of repair, and, in the leg, for example, considerable inversion of the foot may follow.

In bones unsupported by a neighboring bone, shortening is likely to be great. Practically it is impossible to maintain the normal length of the femur or humerus during the period of regeneration by any method of traction or cast support. Bending deformity is also difficult to prevent.

In over 300 cases of acute and chronic osteomyelitis which have entered the surgical service of the University Hospital between January 1, 1915, and May 1, 1923, the operation of subperiosteal resection has been performed in five. In two of these the operation was done in this hospital, while three came to the hospital because of the unsatisfactory end-result following the subperiosteal resection which had been performed elsewhere. In only one of the five cases did regeneration of bone proceed to the development of a weight-bearing new shaft. This was of the femur. The remaining four cases were of the tibia, the bone which theoretically should be the most satisfactory for this type of operation. In all of these, osteogenesis stopped far short of the production of a new shaft so that transplantation of bone became necessary to obtain a weight-bearing extremity. In four of the five cases, further operation was necessary following subperiosteal resection, before the infection was cured. In other words radical removal of the shaft of the infected bone did not completely eradicate the infection. In all of the cases considerable deformity occurred.

A description and analysis of these five cases follows:

Case 1. Margaret Murphy, age 3.

History on entrance to University Hospital, February 21, 1916. About 6 weeks ago the child burned one of the toes of her right foot, which seemed to heal satisfactorily. Two weeks later the toe became very painful. The following day a red, tender area was noted on the outer side of the ankle. This increased in extent and the leg became swollen, painful and tender from the ankle to the knee, and the patient had a fever of 104 degrees. One week later an incision was made and a large amount of pus found. The patient was brought to the University Hospital 4 weeks after the onset.

Fig. 10.

Fig. 11.

Fig. 10. Case 3. Over 3 years after subperiosteal resection of the tibia there is a complete defect of the shaft. In the 9 months' period during which this boy has been under observation, no bone has been formed in the region of the defect and a detached piece of considerable size has been absorbed.

Fig. 11. Case 3. Result 5 months after transplantation of bone taken from the opposite tibia.

Examination shows a well-nourished girl of three, with left leg markedly swollen, reddened, and extremely tender. Leucocyte count 15,200.

X-ray shows extensive involvement of the medulla of practically the entire shaft of the tibia. There is irregular periosteal new-bone development. No sequestrum is demonstrated.

Operation, February 21, 1916. Ether anæsthesia. (Dr. C. J. Rowan.) Long incision was made over the tibia. The periosteum was incised and reflected from the bone. The lower half of the periosteum was very thick and firm and contained a shell of new bone, while the upper half showed no thickening or bone production except near the upper end. The bone was bloodless, but had not separated and was not loose at either epiphysis. With a chisel the medullary cavity was opened from one epiphysis to the other and found to contain pus. The bone cavity was packed with plain gauze and the incision partially closed by suture.

Course. The acute symptoms subsided. Drainage from the wound was profuse and did not subside. It was felt that major portion of shaft was necrotic.

Operation, March 24, 1916. Ether anæsthesia. The necrotic tibia was divided at its middle by Gigli

Fig. 12. Fig. 13. Fig. 14.

Fig. 12. Case 4. Roentgenogram taken about 7 weeks after the onset of acute osteomyelitis of the tibia, and just preceding subperiosteal resection.

Fig. 13. Case 4. Defect present 5 months after the operation.

Fig. 14. Case 4. Thirteen months have elapsed since the roentgenograms shown in Figure 13 were taken. No new bone is shown across the defect. The tibial stumps are slightly longer, but the defect is wider due to the efficient splinting by the fibula which has increased over an inch in length.

saw and cutting forceps, and each fragment avulsed from its point of beginning separation from the living bone. This left a defect representing approximately one-half of the shaft of the tibia. A plaster splint was applied.

Course. Gradual healing of the wound took place. From May until December, 1916, the patient was at home. At intervals sinuses would develop in the scar, drain for a time, and then heal over. She returned to the hospital in December, 1916, at which time three sinuses were present over the lower end of the tibia. There was incomplete regeneration of the tibia as shown by very free false movement through the middle third of the leg.

Operation, December 14, 1916. Ether anæsthesia. A localized area of infection just above the ankle joint was opened into and drained.

Course. Discharge became very much less and no no new sinuses developed. Patient returned to the hospital in February, 1917, at which time there was still a persistent sinus just above the ankle at the site of the last operation. There was slight decrease in the tibia defect. This was due in part to a very slight production of new bone from each fragment and in part to an actual foreshortening of the bone in spite of the support of the intact fibula and a supporting cast. Ten and one-half months had elapsed since the removal of the tibial shaft.

Operation, February 12, 1917. Ether anæsthesia. (Dr. C. J. Rowan.) The defect in the right tibia was exposed and the pointed end of each fragment freed by dissection. A graft, 2.5 inches in length, was cut from the left tibia, placed across the defect, and tied to the upper and lower fragments by chromic gut.

Course. The wound of the right leg became mildly infected, but the graft healed in spite of this infection and a solid bone developed giving a satisfactory weight-bearing tibia as the end-result.

Examination, May 2, 1923, six years following operation. There is practically normal range of motion of the ankle and knee joints. The foot is somewhat everted due to bowing of the tibia. The bone is solid and nearly of the same size as the left.

The right limb is 2 centimeters shorter than the left, measuring from the anterior superior spine of the ilium to the tip of the internal malleolus. The right tibia, however, is 4.5 centimeters shorter than the left. The femur on the affected side has become longer than that of the unaffected, due to the stimulation to which it has been subjected in walking incident to the difference in lengths of the two limbs. The fibula supporting the formerly diseased tibia is also markedly more sturdy than its opposite.

The girl is very active in every way.

CASE 2. Fred Worrell, age 11.

History on entrance to University Hospital, December 31, 1918. Eighteen months ago the patient bruised the left ankle while playing ball. About 6 weeks later a dull ache was noticed in the leg above the ankle which gradually increased in severity until it kept him awake. Three days later the leg began to swell and this extended to the knee in a few days. Not long after he developed a similar pain and swelling of the forearm. A month later a pleurisy developed on the left side. The chest was incised but no pus was found. Several months after this a sinus developed over the right third rib anteriorly. Another sinus developed over the right upper maxilla, and one over the lower end of the right humerus.

An incision was made over the left leg at the onset of trouble and a great deal of pus obtained. A sinus persisted. Nine months ago a subperiosteal resection of the left tibia was done, a piece of bone, 8 inches in length, being removed.

Examination shows an anæmic looking boy of 11 years. There are sinuses over the right third rib, external condyle of the right humerus, distal end of right radius and ulna, upper end of the left humerus, and three sinuses in the scar over the left tibia. The operative scar over the left tibia is anteriorly placed and extends from epiphysis to epiphysis. The leg may be bent and twisted freely through a wide range. This is limited only by the intact fibula. No tibia is palpable except in the regions of the knee and ankle. X-ray shows an extensive gross defect in the shaft of the left tibia involving the whole bone except for a stump about 3 inches in length at the upper end and a shorter one at the lower. Between these two bone ends is an incomplete narrow ribbon of new bone which varies somewhat in width and thickness. Von Pirquet and Wassermann tests negative. Leucocyte count 18,200.

Operation, January 9, 1919. Ether anæsthesia. (Dr. C. J. Rowan.) The sinuses over the tibia were opened and found to lead to cavities in bone which contained spicules of bone and pus. These were curetted and packed with iodoform gauze.

Course. The limb was supported by a cast from the toes to above the knee, which was changed at

Fig. 15.

Fig. 16.

Fig. 15. Case 5. Eleven weeks after subperiosteal resection of a considerable portion of the shaft of the femur, osteogenesis is well established. Traction is applied to the limb by a Thomas hip splint. The mesial bending deformity was subsequently corrected in large measure.

Fig. 16. Case 5. Ten and one-half months after operation the new femur is well formed. Removal of a sequestrum from a central abscess was necessary before the infection was overcome.

varying periods. The wounds continued to discharge for several months but healing was complete by April, 1920. The ribbon of bone between the upper and lower tibial fragments became increasingly smaller in size due to absorption. When there had been no further evidence of infection for 4 months, bone transplant was performed.

Operation, July 24, 1921. Ether anæsthesia. (H. L. Beye.) A long incision was made over the anterior surface of the left leg lateral to the old scar and the ribbon-like tibia exposed. In places it was quite well formed and as thick as a pencil. In other places there was no true bone, but only a thick ribbon of tough periosteum surrounded by scar tissue. A graft was taken from the right tibia, 8.75 inches long and 0.75 inches wide, and of the full thickness of the bone from periosteum to endosteum inclusive. A bed was prepared in the left leg for the graft by splitting the ribbon-like tibia, and cutting a short trough in the tibial stumps with a chisel. The graft was laid in this bed and held in place by sutures, and the incision closed. Cast applied.

Course. A mild infection of the wound of the left leg took place which required that the incision be opened at a few points for drainage. The graft lived in spite of it and grew actively. It even threw off from its anterior margin a shell-like sequestrum of considerable size, following which the wound healed completely.

End-result. A well-formed tibia developed from the grafted bone which assumed the size and shape of a normal tibia and the structural characteristics including a fairly well outlined medullary canal as shown by the X-ray. There is shortening of 6.5 centimeters of the limb, and some inversion of the foot due to the foreshortening of the tibia. Range of motion in the ankle joint is somewhat restricted. The boy is active, walks well with the shoe built up and has had no further evidence of infection in the leg and it is now nearly 3 years after the bone graft operation.

Operation was performed upon the involved rib and a cure obtained. The involvement of the superior maxillæ, right humerus, ulna, and radius subsided spontaneously.

Fig. 17. Fig. 18.

Figs. 17 and 18. Case 5. Three years after operation the femur is seen to be substantial. There is moderate posterior bowing. The limb is 7.5 centimeters shorter than the opposite.

CASE 3. Carl Brewer, age 9.

History on entrance to University Hospital, October 3, 1921. January 10, 1919, the patient developed severe pain in left leg, referred especially to the ankle, and had a fever of 102 degrees. In 16 hours the entire leg was swollen and reddened. Three weeks following onset, incisions were made in the soft tissues and considerable pus obtained. During the sixth week of illness, the leg became fractured on turning over in bed. The following day the patient was taken to a hospital for operation. The "bone was sawed and chiseled out," following which improvement began at once, and healing of the wound was complete in 4 months. Casts were applied at intervals for 18 months and then a brace was used. A few days after the leg was incised for drainage a red tender "gathering" appeared in the right wrist. This was incised, pus obtained, and this infection was healed in about 4 weeks. It has caused no later trouble. Was sent to the University Hospital for a bone graft operation 31 months following resection of the tibia.

Past history. No history of trauma to the leg can be obtained. Denies furuncles or other skin infections. Otherwise negative.

Examination shows a well-nourished boy of 9. General examination negative. Left leg presents a scar over practically the entire anterior aspect of the tibia, with three small scars lateral to this, where the initial drainage had been established. The leg is 7 centimeters shorter than the right. A palpable defect in the tibia of about 1.5 inches is present in the middle third. There is free motion of the leg in all directions through this defect. There is considerable atrophy of the calf muscles. Ankle and knee joint movements are satisfactory. X-ray examination shows a gross defect in the middle third of the tibia of about 1 inch. The upper tibial fragment tapers to a point and is quite dense. The lower tibial fragment is also tapered, and its most proximal portion is separated from the remainder by what seems to be a fracture line. Lateral to the defect between the two main tibial fragments is a sclerotic fragment of bone which is entirely separate from the remainder of the tibia. There is no evidence of active infection.

There is a greater defect in the tibia than is apparent. This is due to the fact that, although the fibula has tended to maintain the normal length of the leg, actual displacement of the upper tibial fragment downward, and of the lower tibial fragment upward, has occurred. This has foreshortened the leg considerably. The fibula is also shorter than that of the normal leg, and due to the unusual stress which has been put upon it, it has become more sturdy.

Inversion of the foot due to tilting of the lower fragment is quite marked.

Course. The leg was massaged daily to better the condition of the soft tissue, make the scar more supple and to light up any latent infection. The boy ran an irregular low grade fever and developed a local point of tenderness in the upper tibial fragment. Operation was performed and a well-localized abscess, the size of a navy bean, found which contained chronic granulation tissue. It lay in very sclerotic bone. Healing was slow, but was complete by February 1, 1922. He was sent home on crutches with the limb supported by cast.

Bone graft operation was performed June 30, 1922, (H. L. Beye), after the former operative wound had been healed for 5 months. During this interval no evidence of osteogenesis was present in the X-ray pictures, and the fragment of bone which had lain on the outside of the gap, between the upper and lower tibial fragments, was almost completely absorbed. A tibial graft, 8.5 centimeters long and 1.5 centimeters wide, consisting of the full thickness of the tibial wall, was taken from the right leg and transplanted into the left tibia. In addition small "cambium grafts" (thin chips of cortex with attached periosteum) were laid along the massive graft in the defect between the upper and lower tibial fragments.

Postoperative recovery was uneventful.

End-result. The result is very satisfactory as far as the development of a solid weight-bearing tibia is concerned. The left limb is 7.5 centimeters shorter than the right for which the boy wears an extension sole and heel. He also wears a brace to correct the inward bowing of the leg and inversion of the foot due to the foreshortening of the tibia, and gets around very actively.

CASE 4. Bessie Van Matre, age 4 years. Seen in office consultation in September, 1922. This case is reported through the courtesy of Dr. John R. Harger, of Chicago, to whom I am indebted for the X-ray illustrations and the clinical data.

History. At the age of 2½ years, this patient had an acute attack of osteomyelitis involving the entire shaft of the tibia. When seen by Dr. Harger 7 weeks after onset she was desperately ill. At that time the leucocytes numbered 15,000, hæmoglobin was 60, and the red cells were below three millions. X-ray examination of the tibia showed a very extensive involvement with considerable central destruction. Operation was performed in March, 1919, at which time complete subperiosteal removal of the infected tibial shaft was done.

Course. A satisfactory recovery took place with complete healing of the wound and no evidence of further infection after 6 weeks. Regeneration of the tibia from the periosteum has not taken place, so that there is a wide defect between the short bone stumps of the upper and lower ends of the tibia, 4 years following operation. An analysis of the X-ray pictures taken about 1 year and 6 months following operation and compared with those taken 2 months after operation, shows that there has been a slight increase in length of the lower stump. Whether this is due to regeneration from periosteum or to epiphyseal bone growth, it is impossible to say. There has been practically no increase in length of the upper stump. The defect between the two stumps has increased in spite of the slight lengthening of the lower stump. This is due to the efficient splinting by the fibula

which has grown well over an inch in length in this 18 month period. The fibula of the affected side is only about 1 centimeter shorter than the one on the normal side, while there is a difference of 2.5 centimeters in the comparative lengths of the two tibiæ.

CASE 5. Lewis Chambers, age 14.

History on entrance to University Hospital, April 22, 1919. In early March, 1919, the patient developed an infected abrasion over the left heel from an ill-fitting shoe. About three days after this both knees, and the left elbow, and the left ankle became swollen, painful, tender, and red. These symptoms gradually subsided. About 3 weeks after this a painful swollen tender area developed over the anterior surface of the right leg below the knee. This was incised and pus obtained. A diagnosis of osteomyelitis of the tibia was made and the boy sent to the University Hospital, about 6 weeks after onset.

Examination. General condition poor. The boy appears anæmic and septic. Pulse rate 120. Over the right tibia in the middle third are two sinuses leading to bone, and tenderness is marked over the entire bone. There is tenderness on deep pressure over the left tibia and the leg and ankle are swollen and œdematous. The left thigh is swollen from the knee to the hip and there is slight tenderness over the femur. Urine analysis shows: specific gravity, 1.022; albumin, negative; many hyaline and granular casts. Hæmoglobin, 79 per cent; leucocyte count, 19,800.

X-ray examination. Extensive osteomyelitis of the left femur involving the entire shaft is present. In the middle third there is considerable destruction of the cortex on the mesial and posterior aspects. The medullary cavity throughout is moth eaten, and small abscess cavities may be made out. There is no evidence of gross sequestration. Periosteal production of new bone is well established and is excessive in the middle third overlaying the area of cortical involvement. The knee joint is intact. There is involvement of the upper third of the right tibia and lower third of the left.

Operation, April 24, 1919. Ether anæsthesia. (Dr. E. M. Miller, Chicago.) A long incision was made over the outer side of the left thigh to the femur. Pus was found around the bone. The periosteum was much thickened and new bone was formed from its under surface. Pus was present between the periosteum and cortex. Almost the entire shaft of femur seemed to be necrotic, so a subperiosteal resection of the shaft was done. The wound was lightly packed with plain gauze and left widely open. An incision was also made over the right tibia to drain the abscess in the soft tissues overlying the bone.

Course. Immobilization of the left limb and traction maintained by a Thomas splint. The wound of the thigh was treated by the Carrel-Dakin method, and healing progressed satisfactorily. Sufficient traction could not be obtained by Buck's extension to maintain the normal length of the extremity, so that calipers were applied to the lower end of the femur above the condyles. Even by weight traction on the calipers with the limb supported in a Thomas splint slung from a Balkan frame, gradual shortening of the extremity took place during the course of wound healing. A hip spica was applied on the one hundred and third day following operation. Bone developed from the periosteum to form a new and solid femur, but a persistent sinus leading into the depth of the new bone remained.

Operation, April 24, 1920. (H. L. Beye.) Nitrous-oxide anæsthesia. Incision through the old scar on outer aspect of left thigh to expose the sinus. The latter led to the interior of the very dense femur. A piece of the latter was removed by chisel and an abscess cavity exposed containing a sequestrum, 2 inches long and three-quarters inch wide.

Course. Uneventful recovery with the wound healed completely at the end of about 3 months. The patient was operated upon again in September, 1920, because of the infection of the right tibia. An extensive abscess was opened, containing a large sequestrum. Healing was uneventful.

End-result. A solid, weight-bearing femur was obtained with infection seemingly entirely overcome 15 months after the operation of subperiosteal resection. There is complete extension of the knee but flexion is limited to an angle of 110 degrees. In spite of every effort made to prevent shortening, the left limb is 7.5 centimeters shorter than the right. How much of this is due to contracture of the thigh muscles, and how much to inhibition of epiphyseal bone growth because of absence of stimulus over a long period of time, it is impossible to state.

The boy now gets around actively although with a decided limp, and there has been no evidence of further trouble nearly 3 years following complete healing of the thigh.

CONCLUSIONS

It is fundamentally unsound to do a subperiosteal resection of the shaft of a long bone for osteomyelitis.

In performing such an operation bone may be sacrificed, which if properly drained, would not only be viable but play an important part in the restitution of the diseased shaft.

Regeneration of bone from the periosteum remaining after subperiosteal resection may be limited and stop far short of a functional end-result.

Deformities are likely to follow such an operation with resultant functional disability.

The radical removal of diseased bone by this procedure does not necessarily mean that infection has been eliminated.

DUODENAL HERNIA—A MISNOMER

By EDMUND ANDREWS, M.D., Chicago

MY attention was drawn to the unusual condition of duodenal hernia, by the case which is outlined as follows:

W. D., had suffered from slight, vague, gastric distress for several years. This in itself had been negligible, but at times a large, palpable mass had appeared in the abdomen. This mass varied in size and was always soft and fluctuating. After considerable study Dr. B. W. Sippy made a diagnosis of probable mesenteric cyst and referred him for operation, which was performed by Dr. E. Wyllys Andrews and the author. The entire small intestine, except for a few inches at its upper and lower ends, was found enclosed in a sac of peritoneum. Large vessels, which could not be identified, lay about the mouth of this sac. A small opening was made at the fundus, and it was found that the entire contents were matted together by universal, fine, cobweb-like adhesions. The patient's symptoms did not warrant such a severe procedure as reduction of the bowels, and therefore the hole in the sac was closed and the abdomen sutured. The condition was a duodenal hernia, but it was impossible to say whether it was a right or a left one. Figure 1 taken from Moynihan represents exactly the condition found in our case.

The older literature on this subject is voluminous, and many careful studies of the various folds and fossæ about the duodenojejunal junction have been made. Hundreds of cadavers, not only of adults but of infants and fetuses, have been examined and every possible type of fold and pouch has been catalogued and named. No one individual has all these structures, and they should really be classed as variants. The most painstaking and minute descriptions are those of Treitz (95), Waldeyer (100), Gruber (36), Eppinger (23), Landzert (53), Jonnesco (47), and Broesike (11). They are admirably summed up by Moynihan (63) in his book on *Retroperitoneal Hernia*. He enumerates nine fossæ as follows: (1) superior duodenal fossa; (2) inferior duodenal fossa (with (1) makes up fossa of Treitz); (3) paraduodenal fossa (fossa of Landzert); (4) mesocolic fossa; (5) mesentericoparietal fossa (fossa of Waldeyer); (6) posterior duodenal fossa (fossa of Gruber); (7) recessus intermesocolicus transversus; (8) duodenojejunal fossa; (9) infraduodenal fossa.

He considered only the first five to be of any practical importance. Numbers 1 and 2 or combinations of them are said to be the anlagen for left duodenal hernia, No. 5 for mesocolic hernia, and No. 4 for right duodenal hernia. This classification differs from some of the earlier ones, notably that of Broesike (11), but it has been almost universally accepted.

There is not a dissenting voice to the view that such small peritoneal pouches are the starting points for these enormous hernias. The prevalent conception seems to be that perhaps one of the pockets was congenitally a little larger and that into this a loop of bowel herniated. By gradual expansion the sac was stretched larger and larger until practically all the small intestine was swallowed up. Treitz (95) (quoted by Moynihan) writes as follows:

"The essentials . . . enumerated as being indispensable for the formation of a left duodenal hernia are three, namely: (1) the existence of a fossa and its boundary folds; (2) the presence of the inferior mesenteric vein in the fold; (3) freedom of movement in the small intestine to such an extent as to permit of its introduction into the hernial sac formed at the expense of the fossa."

Moynihan (65) himself says: "In its gradual augmentation of size, the hernia will be affected by (1) the laxity of the retroperitoneal tissue and (2) the extensibility of the peritoneum.

"1. The subperitoneal tissue is the stratum in which the hernial sac rests, and from the first the increase in size of the hernia is due to the sac pushing its way in and among this generally lax membrane. If for any reason the subperitoneal tissue should be unusually dense, fibrous, inelastic, or inexpansible, to so much greater a degree will the increase of the hernia be impeded.

"2. So far as concerns the extensibility of the peritoneum, there is little to be said. In the absence of any adhesions, the result of an old peritonitis, the membrane lends itself readily enough to any increase in size of an intra-abdominal tumor, wherever originating."

Since the publication of Moynihan's book (1906) as each case has been discovered and published, the same mechanism has been assumed and the same authors and theories quoted in a multitude of papers. The absurdity and grotesqueness of this whole conception must be evident from a consideration of the following facts:

1. *Differential pressure is utterly lacking.* All these pouches are enclosed within the abdominal walls in exactly the same way as is the general peritoneal cavity. None of them reaches outside in any way or is in the neighborhood of any opening. As intra-abdominal pressure increases, the rise must be just as high within the pouch as in any other part of the belly. In other words, the pressure in the main cavity can never rise higher than within the pouch. Any *vis a tergo* to account for the formation or growth of such a hernia is totally absent.

2. There are literally *hundreds of similar folds and fossæ* in the peritoneum, many of which are of much greater size, and they are practically never the sites of such "hernias." About the broad ligaments, the transverse mesocolon, the root of the great mesentery, about the splenic and hepatic flexures of the colon, not to mention the foramen of Winslow, occur all the features of the anatomy of the duodenal folds only vastly more pronounced in character and greater in size.

3. In all but a very small minority of cases reported, *the degree of herniation has been total or subtotal.* Seldom is there more than 15 to 20 centimeters of the small intestine in its normal position. How can one conceive of a force which would, once begun, practically always continue to act until all the guts had been segregated into a sac, even when the rest of the belly was empty? Jonnesco (66) has tabulated the *smallest* cases on record. The measurements refer to dimensions of the sac.

Reporter	Centimeter
Gruber	2.5– 1.5
Lambl	8. –10.
Gruber	11. –14.
Lambl	14. –12.
Krauss	18. –12.
Krauss	20. –16.5
Gruber	24.5–14.5

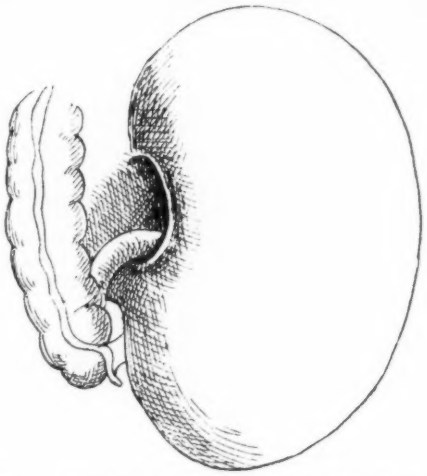


Fig. 1. Schematic drawing taken from Moynihan and representing exact condition found in author's case.

It will be noted that even of these smallest ones, the last three are large enough to have contained most of the small bowel. A few smaller ones have been reported since, notably MacArthur's (55) which I believe to be the smallest on record.

Of the 60 cases I have collected, 90 per cent have over one-half of the small bowel in the sac. Of this 90 per cent all but three were total or subtotal.

4. Vogt (98) reports a case in which such a hernia was found total in a newborn infant. Several others have been reported in the very young (Manski, 50). Surely one cannot believe that intra-abdominal pressure *in utero* has been the cause of such a "hernia."

5. The herniated viscera are never anything but small bowel. Omentum, the viscus found in nine out of ten hernias of other sorts, has never been reported as being in the sac. In only one case, that of Pybus (77) was a few inches of the descending colon herniated. This is the only report in which any other viscus is involved.

6. In many of the cases there has been an almost universal growing together of the contents of the sac. Kohlmann (50) has applied the term "totalis accreta" to this condition. It has often occurred in cases giving no history of strangulation. Heller (40) speaks

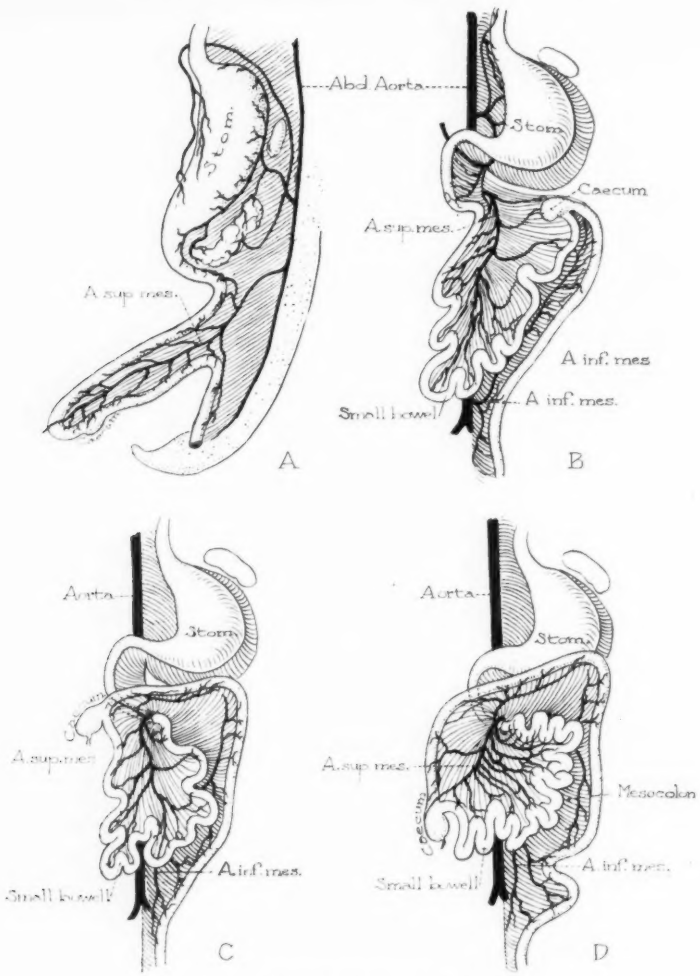


Fig. 2. Normal development of colon.

of this and the author's case was of this same type. The adhesions are not strong and firm and do not give the appearance of being inflammatory. They are thin, and the whole has rather the appearance of retroperitoneal tissue.

In my opinion this disease is a *congenital anomaly in the development of the peritoneum*. If looked at in this light, the explanation of these so-called hernias is quite simple and rational. By this means also can the various pericæcal hernias be explained.

Let us consider for a moment the normal development of the peritoneum. In the second month of intra-uterine life the cæcum lies above the umbilicus and generally a little to the left (Fig. 2, *b*). The small intestines are in the lower right half of the belly. This condition is brought about by a rotation on its long axis of the umbilical loop of Todt (Fig. 2, *a*). This is the first loop formed in the hitherto straight intestinal canal. It projects outside the body into the yolk stalk, and at its end is

given off the omphalomesenteric duct. This may persist as a Meckel's diverticulum. Failure of this loop to be re-included within the body gives rise to amniotic hernia. This loop is the anlage of the jejunum, ileum, ascending colon, and most of the transverse colon, the entire superior mesenteric artery tract. Normally a rotation of the entire loop occurs. The distal limb swings to the left and upward, coming to lie in the left upper quadrant (Fig. 2, *b*). It will be noted that this rotation takes place in the opposite direction to that in which the cord is usually twisted.

As the small gut grows rapidly and its coils multiply, the development of the colon progresses more slowly and in a much less haphazard manner. At this stage, ascending and transverse colons do not exist. As the upper end of the colon grows, it spreads to the right and its mesentery forms the transverse mesocolon (Fig. 2, *c*). The cæcum grows much more slowly and it is only when the hepatic flexure has become established and fixed that the downward growth of the descending colon begins. As it finally reaches down into the iliac fossa, its mesentery becomes attached to the posterior abdominal wall and fuses with it (Fig. 2, *d*). To sum up, the colon grows across the abdomen superiorly to the small bowels and then down, thus avoiding imprisoning them in its mesentery.

The simplest form of anomaly will produce a so-called right duodenal hernia. In this form the sac lies to the right of the duodenum and the superior mesenteric artery or the ileocolic artery always lies in the free edge of the fold making the anterior sac wall (Fig. 3). Let us now suppose that the rotation of the umbilical loop is not carried to completion. I venture to offer the suggestion that this may be due to its remaining outside the body too long and being involved in the opposite twisting of the cord, or by the persistence of the allantois to a later stage. In Borchard's (9) and also in one of Aschoff's (3) cases, a persistent Meckel's diverticulum was noted, and in several others duodenal hernia was associated with other defects in the development of the abdomen.

The cæcum then would not lie superior to the small intestines (Fig. 4, *a* and *b*), and, as it

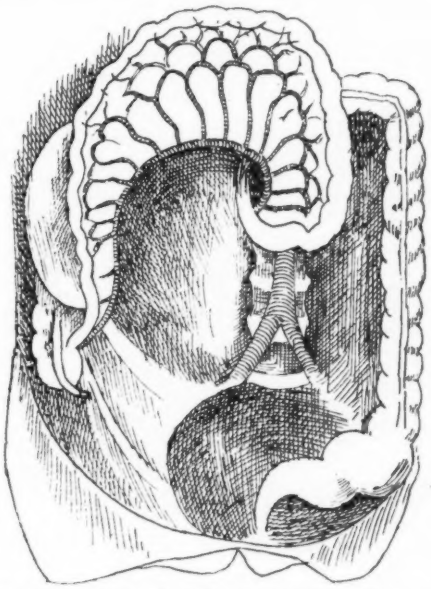


Fig. 3. Right duodenal hernia, showing orifice of the sac bounded by the superior mesenteric and ileocolic arteries (*Gerard-Marchant.*)

grew to the right, the small bowel would be caught in its mesentery (Fig. 4, *c*), and finally when its mesentery became adherent to the right posterior abdominal wall, the imprisonment would be complete (Fig. 4, *d*). The superior mesenteric and ileocolic artery would lie in the free edge of the neck of the sac. All the conditions of a right duodenal hernia are exactly reproduced.

The mode of origin of a left duodenal hernia is merely a higher degree of the same process. In this condition the hernia lies to the left of the duodenum and the free edge of the sac has the inferior mesenteric artery and vein in it (Fig. 5). The hernia lies between the artery and vein which make up the "fascular arch of Treitz" (Fig. 6). Now let us suppose that no rotation of the loop occurs, or perhaps there is a little in the wrong direction (Fig. 7, *a*). The cæcum would then lie to the right of the mid line in the lower abdomen. The colon runs straight to the rectum. As it gains in length, it forms a loop, and when the cæcum seeks its normal primitive position in the left upper quadrant, the small bowel is caught be-

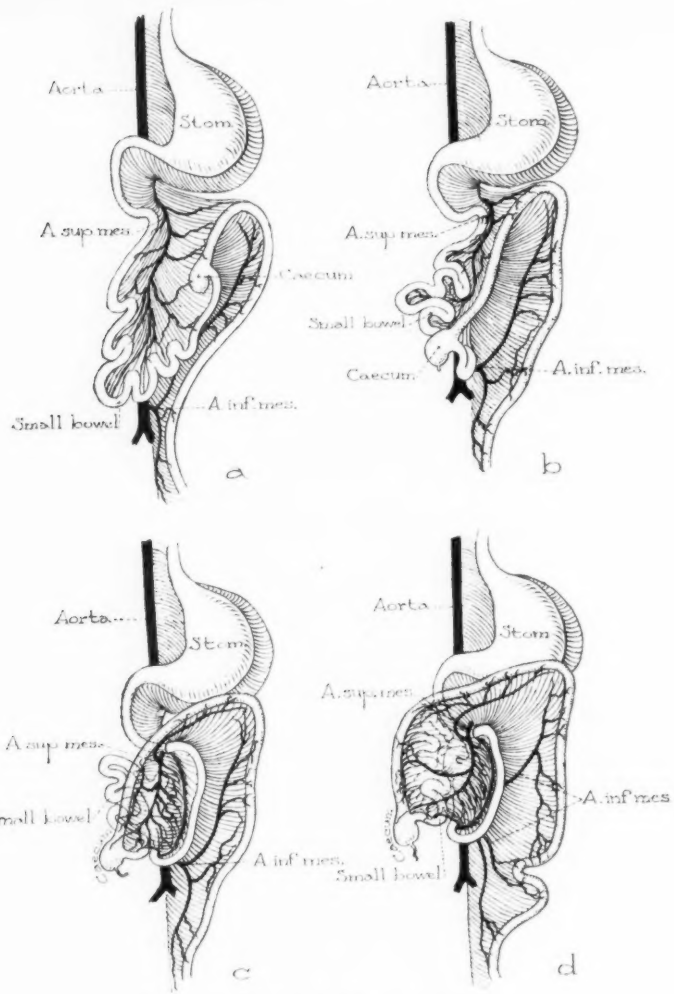


Fig. 4. Production of right duodenal hernia.

neath the mesentery of the descending colon (Fig. 7, *b* and c). The inferior mesenteric artery would then lie in the free edge of the sac neck and the vein would lie above, thus making the vascular arch of Treitz, which has been noted in most of these hernias.

Moynihan, in 1906, collected 74 cases of duodenal hernia, 57 of which he classified as left, and 17 as right. Since that date no complete collection has been made. Short (89), in 1916, gathered 14 since 1906, and Desjardines (20), in 1918, added four more. The reader must be referred to Moynihan's book (63) for the details of his cases. Short's and Desjardines' are included in the following series of 60 cases which I have collected since 1906. (Table I.)

The following articles were for various reasons not available, but I have reason to believe either from their titles or from references made by others that they record actual

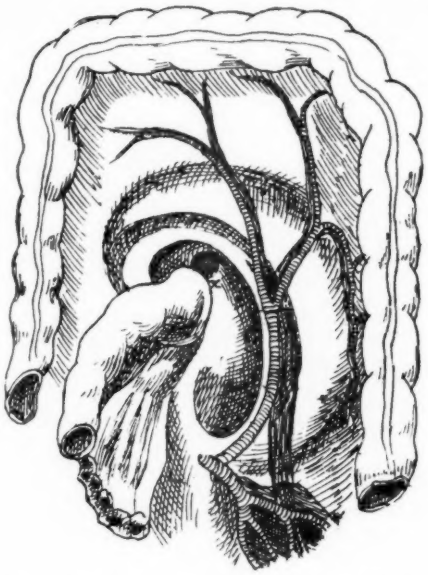


Fig. 5. The fossa of Landzert and the fossa of Gruber, *x*. Paraduodenal fossa and posterior duodenal fossa. (*Moynihan.*)

cases. D'Este (21), Eisler and Fischer (22), Iacobovici (46), Lamas (52), Levit (54), Scholz (85), Strohmeyer (92), and Wagner (99).

The cases shown in Table II, reported prior to 1906 are not included in Moynihan's collection.

In such a work as this it is certain that there has been some reduplication of cases, in spite of all precautions. In my tables, I have included no two cases of the same age and sex in order to avoid this. Nevertheless it may be that some of those published as museum specimens have been previously published without the second reporter knowing of it. I have not attempted to classify my cases right or left, as this has in many cases seemed a matter of great doubt. I have also omitted all mention of cases of mesocolic hernia, although I believe it quite possible that it has a similar origin.

Finally, I have appended a list of references to duodenal hernia not in Moynihan's bibliography, many of which I have not been able to consult. Many of these are duplicates of the cases reported, as for example when

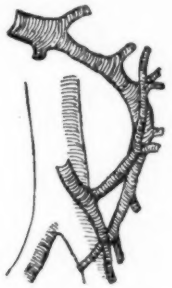


Fig. 6. The "vascular arch" of Treitz. (*Moynihan.*)

both the pathologist and the surgeon reported different aspects of the same case in different journals.[1]

Most of the earlier cases were observed post-mortem. However, of the 61 reported since 1906, 34 were operated upon, most of them during a crisis, and 12 died, a mortality of 36 per cent. None of the three operated upon during a quiescent period died. This does not, however, tell the whole story. In several of the cases reported recovered no radical cure was attempted. In these the patient got well in spite of the operation and not on account of it. If these are omitted it brings the mortality of operative cure well over 50 per cent. In some cases, universal adhesions prevented any attempt at reduction. (Author's and Heller's (40) and others.) In others the symptoms did not warrant the attempt, as the hernia was only incidental pathology and had given no trouble. In most cases the reduction has proven difficult. The ring cannot be enlarged on account of the important blood vessels in the neck of the sac. Extreme force is often necessary and tearing of the bowel has often occurred. Shock is intense from much handling of the intestines. The majority of fatalities have been due to peritonitis or shock.

Only one case has been diagnosed before operation, that reported by Sherren (88). In our case the diagnosis made by Dr. Sippy, mesenteric cyst, was as close as it is possible to come. Although they did not suggest the true diagnosis the radiological findings were typical. Kummer has described these and they corresponded closely with those found in our case.

[1] See references in bibliography before which asterisk appears.

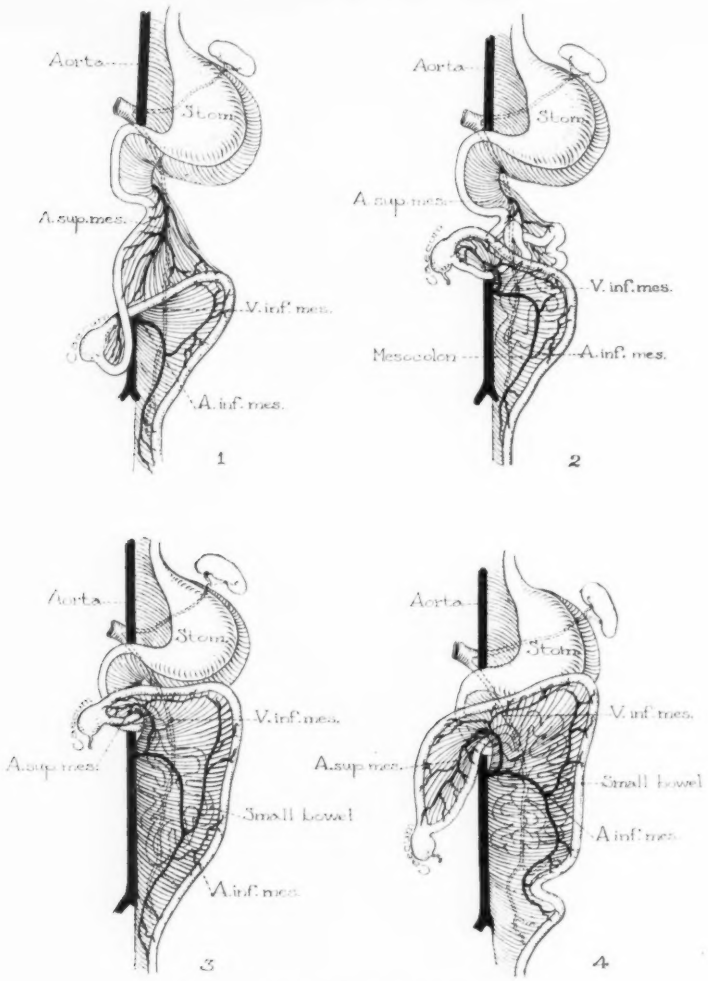


Fig. 7. Production of left duodenal hernia.

Of all cases on record the greater number gave no symptoms whatsoever and were discovered only accidentally at postmortem or in the course of a laparotomy for some other condition. In those which did make trouble, there was generally a history of several previous acute abdominal crises. When first seen patient presented a picture of acute ileus: shock, collapse, vomiting, tympanites, obstipation. A palpable mass, generally on left side and of variable size, was noted in only a few cases.

CONCLUSIONS

Duodenal hernia is a congenital anomaly due to imprisonment of the small intestine beneath the mesentery of the developing colon.

BIBLIOGRAPHY

1. ABEE. Beitr. z. path. Anat. u. z. allg. Path., Jena., 1901, xxix, 117.
2. ADENO and JOUBELAY. Lyon méd., 1891, p. 240.
3. ASCHOFF. Berl. Klinik, 1896, No. 100.
4. BARKER. Tr. Clin. Soc., Lond., 1906, xxxix, 136.

TABLE I.—CASES REPORTED SINCE 1906

		Sex	Age	Pm.	Op.	Strang.	Rec.	Type	Degree	Symptoms	Remarks
1	Barker (4)	M	56	o	x	o	x	lt.	Total	None	Discovered incidentally in operation for cancer of stomach.
2	Bassedas (5)	.....	.....	x	o	x	o	lt.	Total	Acute ileus	Found at autopsy.
3	Basset (6)	M	80	x	o	o	o	lt.	1 meter	None	Died of cardiorenal disease.
4	Basset (6)	M	26	x	o	o	o	rt.	Total	History unknown	Specimen from museum.
5	Basset (6)	C h i	l d	x	o	o	o	rt.	1–2 cm.	History unknown	Specimen from museum.
6	Beneke and Lorenza (7)	M	45	x	o	o	o	lt.	Total	None	Died of nephritis.
7	Borchard (9)	M	32	x	x	x	o	lt.	Subtotal	Acute ileus	Not discovered at first operation; found at second.
8	Bramlett and Ashhurst (10)	M	47	o	x	x	o	lt.	Subtotal	Acute ileus	Died on ninth day because wound broke open.
9	Carson (14)	M	29	o	x	?	x	rt.	Subtotal	?	Discovered at laparotomy.
10	Crescenzi (15)	.....	.....	o	x	o	x	lt.	Subtotal	Ileus twice previously	Stormy convalescence.
11	Crisler (16)	.....	.....	.....	x	x	x	?	?	?	Reference not available; referred to by Short.
12	Davis (18)	M	48	o	x	x	o	lt.	Total	Acute abdominal crisis	Reduced with difficulty on account of adhesions.
13	Dayton (19)	M	50	x	o	o	o	lt.	Total	None	Died of tuberculosis
14	Desjardines (20)	M	56	x	o	o	o	lt.	Total	None	Died of lymphosarcomatosis.
15	Felton (24)	F	15	o	x	o	o	lt.	Total	Mass in abdomen	Diagnosed as ovarian cyst.
16	Giemanovich (28)	.....	.....	.....	.....	.....	.....	rt.	.....	Details not available	Not available.
17	Gierke (30)	M	64	x	o	o	o	lt.	8 ft.	None	Died after prostatectomy.
18	Giessen (29)	.....	.....	.....	x	x	x	?	?	Details not available	No other details available.
19	Gobiet (31)	M	28	o	x	x	x	lt.	Subtotal	Acute ileus	Bloody fluid in belly.
20	Grad (33)	F	52	o	x	o	x	lt.	Subtotal	Backache	Cured by operation; easily reduced.
21	Harttung (39)	M	44	o	x	x	x	lt.	Half	Ileus chronic	2.20 meters gut resected.
22	Harttung (39)	M	54	o	x	x	o	lt.	Total	Acute ileus	Reduction very difficult.
23	Haasler (37)	M	43	x	o	x	o	lt.	Total	Vomiting	Operation for cancer of colon. Hernia not seen. Death in 4 days from strangulation of hernia.
24	Haasler (40)	M	10	x	x	x	o	lt.	Total	Chronic dyspepsia	Reduction very difficult.
25	Hallock (38)	F	Adult	x	o	o	o	lt.	Total	?	Not cause of death.
26	Heller (40)	F	Adult	o	x	x	x	lt.	Total	Acute ileus	Universal adhesions prevented reduction. Sac incised to relieve tension.
27	Hichens and Odgers (44)	F	40	o	x	x	x	lt.	Total	Acute ileus	Adhesions noted.
28	Kohlmann (50)	M	51	x	x	x	o	lt.	Total	Abdominal pain and mass	Died of peritonitis.
29	McCallum and Liller (56)	M	41	x	x	x	o	lt.	Total	Acute ileus	Died of pneumonia.
30	Maschke (58)	M	36	x	x	x	o	lt.	½	Acute abdominal pain	Died 7 days after appendectomy done for this crisis. Hernia not noted.
31	Maschke (58)	F	63	x	o	o	o	lt.	Total	None	Died of nephritis.
32	Mathews (59)	M	35	o	x	x	x	lt.	Small loop	Acute abdominal pain	Cured.
33	Merckel (60)	F	46	x	o	o	o	lt.	Total	None	Found at routine post.
34	Mueller (68)	M	47	x	x	x	o	lt.	Subtotal	Acute ileus	Died of shock.
35	Mueller (68)	.....	.....	x	x	x	o	lt.	Total	Acute ileus	Operation failed to discover hernia.

TABLE I.—CASES REPORTED SINCE 1906, *Continued*

		Sex	Age	Pm.	Op.	Strang.	Rec.	Type	Degree	Symptoms	Remarks
36	Nixon (69)	M	30	o	x	o	x	It.	Subtotal	Repeated abdominal crises	Easily reduced.
37	Nuzum and Nuzum (70)	M	40	x	o	o	o	It.	Over ½	None	Routine autopsy; died of pneumonia.
38	Obrastzow (71)	F	17	x	x	x	o	It.	Subtotal	Acute ileus	Paper available only in abstract.
39	Pikin (73)	F	27	o	x	x	x	?	Subtotal	Mass in abdomen	Paper available only in abstract.
40	Priebatsch (75)	.....	.....	x	....	x	o	It.	Total	?	Museum specimen; no history.
41	Pringle (76)	M	40	o	x	o	x	It.	Subtotal	Mass in abdomen	Last 2 to 3 inches could not be reduced.
42	Pybus (77)	M	5	o	x	o	x	It.	Total	Colic	Had some colon in sac.
43	Scheele (82)	M	28	o	x	o	x	It.	Total	Constipation	Cured.
44	Schopf (86)	.....	.....	x	o	o	o	It.	Total	?	Museum specimen; died of other causes.
45	Schopf (86)	F	30	x	o	o	o	It.	Subtotal	?	Museum specimen; died of other causes.
46	Schopf (86)	M	Old	x	o	o	o	It.	Total	?	Museum specimen; died of other causes.
47	Schopf (86)	Adult		x	o	o	o	It.	1st loop jejunum	None	Museum specimen; died of other causes.
48	Schopf (86)	Adult		x	o	o	o	It.	12 cm.	?	Museum specimen; died of other causes.
49	Schopf (86)	Adult		x	o	o	o	?	Subtotal	None	Found at routine autopsy.
50	Schopf (86)	Adult		x	o	o	o	It.	½ small gut	None	Found at routine autopsy.
51	Schoeppler (84)	F	30	x	o	o	o	It.	Total	None	Died of tuberculous kidney.
52	Sherren (88)	F	14	o	x	x	x	It.	Subtotal	Diagnosed	Acute ileus; mass in abdomen.
53	Thomas (94)	M	32	x	o	o	o	It.	Total	None	Found at routine autopsy.
54	Thomas (94)	M	2	x	o	o	o	It.	Partial	None	Died of diphtheria.
55	Van Holst (96)	M	21	o	x	x	x	It.	Subtotal	?	Considerable peritonitis noted.
56	Vautrin (97)	M	32	o	x	o	x	It.	Total	Chronic abdominal pain	Cured.
57	Vautrin (97)	M	31	o	x	o	x	It.	Total	Acute ileus	Ring sutured.
58	Vogt (98)	M	4 days	x	o	o	o	It.	Total	Vomited everything from birth	No adhesions.
59	Wallace (101)	M	35	o	x	o	x	It.	Total	Repeated abdominal crises	Whole sac delivered, emptied, sutured.
60	Weil (102)	.....	.....	x	o	o	o	It.	Total	Diagnosed, appendix abscess	No operation; moribund when seen.
61	Andrews, Edmund	M	37	o	x	o	o	?	Subtotal	Marked adhesions	Vague abdominal distress. Mass.

5. BASSEDAS. An. Acad. y lab. de cien. méd. de Catalunya, 1913, vii, 428.
6. BASSET. Arch. f. path. Anat., etc., cxc, 510.
7. BENEKE and LORENZA. Deutsche Ztschr. f. Chir., 1920, clx, 1.
8. BICKERSTETH. Tr. Path. Soc., Lond., 1864, xvi, 139.
9. BORCHARD. Arch. f. klin. Chir., 1907, lxxxii, 1023.
10. BRAMLETT and ASHHURST. Am. J. M. Sc., 1917, cliii, 641.
11. BROESIKE. Ueber intraabdominelle Hernien und Bauchfelltaschen. Berlin, 1891.
*12. BRUENING. Ein Fall von Hernia duodenojejunalis sinistra. Inaugural dissertation, Wuerzburg, 1894–5.
*13. CAMELOT. J. d. sc. méd. de Lille, 1904, xi, 313.
14. CARSON. Proc. Roy. Soc., Lond., Surg. Sect., 1911, part 5.
15. CRESCENZI. Arch. ital d. chir., 1921, xiii, 421.
16. CRISLER. South. M. J., 1908, i, 71.
*17. DANIEL. Zur Lehre von den retroperitonealen Hernia. Inaugural dissertation, Bonn, 1904.
18. DAVIS. Boston M. & S. J., clxx, 272.
19. DAYTON. Johns Hopkins Hosp. Rep., vol. xviii.
20. DESJARDINES. Ann. Surg., 1918, lxvii, 195.
21. D'ESTE. Correio san., Milano, 1909, xx, 324.
22. EISLER and FISCHER. Hernia Mesentericoparietalis dextra. Leipzig, 1911.
23. EPPINGER. Vrtljhrsb. f. d. prakt. Heilkunde, 1870, 27th yr., vol. 1.
24. FELTON. Arch. f. klin. Chir., 1909, lxxxix, 495.
25. FINLEY and MCTAGGART. Montreal M. J., 1900, xxix, 913.
*26. FLORA. Ueber ein Fall Hernia retroperitonealis Treitzii. Inaugural dissertation, Wuerzburg, 1896.
27. FREEMAN. Am. J. M. Sc., 1903, cxxvi, 594.
28. GEIMANOVICH. Kharkov M.J., 1911, xii, 391.

TABLE II.—CASES REPORTED PRIOR TO 1906, BUT NOT IN MOYNIHAN'S COLLECTION

		Sex	Age	Pm.	Op.	Strang.	Rec.	Type	Degree	Symptoms	Remarks
1	Abee (1)	M	53	x	o	o	o	lt.	Subtotal	None	Had large congenital cystic kidney.
2	Adeno and Joubelay (2)	.....	.....	x	o	o	o	?	Subtotal	None	Classed as mesocolic. Seems typical right duodenal.
3	Aschoff (3)	.....	.....	x	o	o	o	lt?	Large	None	Not typical. doubtful. Had Meckel's diverticulum.
4	Bickersteth (8)	.....	.....	x	o	o	o	lt?	Total	None	Died of other causes.
5	Finley and McTaggart (25)	M	40	x	o	x	o	lt.	Total	Acute ileus	Too sick to be operated upon; died under observation.
6	Finley and McTaggart (25)	Chi ld		x	o	o	o	?	Total	None	Died of burns. Case not seen, only specimen.
7	Freeman (27)	M	47	o	x	x	o	lt?	Total	Acute ileus	Bowel resection. Had 8 inches colon in sac.
8	Freeman (27)	M	47	x	o	o	o	lt.	Subtotal	None	Died of cirrhosis of liver.
9	Grawitz (34)	M	35	x	o	o	o	lt.	Total	None	Died of accident.
10	Herbert (41)	M	40	x	o	o	o	lt.	Total	None	Found at routine autopsy.
11	Hueter (45)	M	56	x	o	o	o	lt.	Subtotal	None	Died of pneumonia.
12	Hesser (43)	.....	.....	x	o	o	o	lt.	¾ small bowel	None	Found at routine autopsy.
13	Manski (57)	.....	.....	x	x	x	o	lt.	Total	Acute ileus	Almost irreducible.
14	Mitchell (62)	F	30	x	o	o	o	lt.	Total	None	Shot in heart.
15	Mitchell (62)	F	4	x	o	o	o	lt.	Total	None	Died of burns. (Probably same as No. 6.)
16	Ogle (72)	.....	.....	x	o	o	o	?	Total	Museum specimen	All small gut behind veil. Not recognized as hernia. Called congenital anomaly.
17	Robinson (78)	M	30	x	o	o	o	lt?	12 in.	None	Called congenital enlargement of fossa.
18	Rose (80)	.....	.....	x	x	x	o	lt.	Total	Acute ileus	Peritonitic death. (Possibly a mesocolic hernia.)
19	Schwalbe (87)	.....	.....	x	o	o	o	lt?	*	None	Died of other causes.
20	Smith et al. (90)	M	20	x	o	o	o	rt.	Subtotal	None	Died of other causes.
21	Thacher (93)	.....	.....	x	o	o	o	?	Total	Not cause of death	No good description.

*Enormous *empty* sac.

29. GIESSEN. Dissertation, Erlangen, 1907.
30. GIERKE. Muenchen. med. Wchnschr., 1907, No. 22.
31. GOBIET. Wien. klin. Wchnschr., 1912, xxv. 450.
*32. GOEBEL. Ueber Hernia duodenojejunalis Treitzii. Inaugural dissertation, Kiel, 1902.
33. GRAD. Am. J. Obst., 1918, lxxvii, 102.
34. GRAWITZ. Deutsche med. Wchnschr., 1901, xxvii, 265.
*35. GRAWITZ and RADEFELT. Deutsche med. Wchnschr., 1901.
36. GRUBER. Arch. f. path. Anat., etc., Berl., xliv.
37. HAASLER. Verhandl. d. deutsch. Gesellsch. f. Chir., 1907, xxxvi, 404.
38. HALLOCK. Surg., Gynec. & Obst., 1918, xxvi, 473.
39. HARTTUNG. Deutsche Ztschr. f. Chir., Leipzig, 1920, clvii, 340.
40. HELLER. Arch. f. klin. Chir., 1909, xc, 361.
41. HERBERT. Bull. et mém. Soc. anat. de Par., 1903, lxxviii, 889.
*42. HERSZKY. Deutsche Med.-Ztg., Berl., xxii, 625.
43. HESSER. Upsala Läkaref. Förh , n.s. ix, No. 4.
44. HICHENS and ODGERS. Brit. M. J., Lond., 1908, ii, 262.
45. HUETER. Muenchen. med. Wchnschr., 1905, lii, 1464.
46. IACOBOVICI. Spitalul, Bucarest, 1907, xxvii, 347.
*47. JONNESCO. Sur l'anatomie topographique du duodenum. Progrès méd., 2d series, ix, 176, 216, 233, 257, 271, 288.
*48. Idem. Hernies internes retropéritonéales. Paris: 1890.
49. Idem. Traite d'Anatomie Humaine. Poirier and Charpy, vol. iv.
50. KOHLMANN. Ueber Retroperitonealhernien. Ein Fall von H. Retro. totalis accreta. Leipzig, 1913.
*51. KUEPFERS. Inaugural dissertation, Berlin, 1899.
52. LAMAS. Med. contemp., 1913, xiii, 129.
53. LANDZERT. Beitr. z. Anat. u. Hist., 1872, No. 1.
54. LEVIT. Časop. lék. česk., Prague, 1912, li, 1597, 1640; 1913, lii, 1387, 1430, 1463, 1527, 1561, 1580, 1624, 1637.
55. MACARTHUR. Surg., Gynec. & Obst., 1906, ii, 67.
56. MACCALLUM and MILLER. Johns Hopkins Hosp. Bull., 1908, xix, 219.
57. MANSKI. Muenchen. med. Wchnschr., 1893, Nos. 23–24.
58. MASCHKE. Deutsche Ztschr. f. Chir., Leipzig, 1911, cxiv, 475.
59. MATHEWS. Northwest Med., 1916, xv, 372.

60. MERCKEL. Muenchen. med. Wchnschr., 1906, liii, 1807.
*61. MEYER. Deutsche Ztschr. f. Chir., vol. liii.
62. MITCHELL. Am. J. M. Sc., 1903, cxxvi.
63. MOYNIHAN. Retroperitoneal Hernia. 2d ed. New York, 1906.
64. Ibid. p. 40.
65. Ibid. p. 47.
66. Ibid. p. 44.
67. Idem. Retroperitoneal Hernia, pp. 48, 49, 50, and 59.
68. MUELLER. Ztschr. f. Path., 1910–11, vi, 136.
69. NIXON. Ann. Surg., 1917, lxv, 456.
70. NUZUM and NUZUM. Tr. Chicago Path. Soc., 1914–15, ix, 191.
71. OBRASTZOW. Zentralbl. f. Chir., xxviii, 979.
72. OGLE. Tr. Path. Soc., Lond., 1860, xi, 107.
73. PIKIN. Arch. f. klin. Chir., 1912, xcviii, 531.
*74. POISSON. Les fassettes périduodénales et leur rôle dans la pathogénie des hernies retropéritonéales. Paris, 1895.
75. PRIEBATSCH. Deutsche Ztschr. f. Chir., cxiv, 602.
76. PRINGLE. Glasgow M. J., 1916, lxxxvi, 65.
77. PYBUS. Brit. M. J., 1916, No. 2.
78. ROBINSON. Cleveland M. Gaz., 1896, xii, 1.
*79. ROGIE. J. d. sc. méd., Lille, 1891, pp. 121, 169, 173.
80. ROSE. Zentralbl. f. Chir., 1903, No. 15.
*81. RUPING. Ein Fall von Hernia retroperitonealis Treitzii. Inaugural dissertation, Tuebingen, 1895.
82. SCHEELE. Zentralbl. f. Chir., 1921, xlviii, 188.
*83. SCHEJA. Morph. Arb., Jena, 1895, v, No. 2.
84. SCHOEPPLER. Arch. f. path. Anat., etc., Berl., 1907, clxxxviii, 235.
85. SCHOLZ. Ztschr. f. Heilk., 1909, xxi, 343.
86. SCHOPF. Beitr. z. path. Anat., 1909, xlvi, 362.
87. SCHWALBE. Ztschr. f. Morphol. u. Anthrop., 1903, vi, 144.
88. SHERREN. Tr. Clin. Soc., Lond., 1906, xxxix, 98.
89. SHORT. Brit. J. Surg., 1915, iii, 48.
90. SMITH, MOULLIN, and KEITH. Lancet, Lond., 1899, p. 1286.
*91. STAUDENMAYER. Duodenojejunalhernie mit Erscheinungen von Darmverengerung. Dissertation, Stuttgart, 1886.
92. STROHMEYER. Ann. d. staedt. allg. Krankenh. zu Muenchen, 1910, xiv, 413.
93. THACHER. Tr. New York Path. Soc., 1888, p. 114.
94. THOMAS. Deutsche med. Wchnschr., xxxix, 2484.
95. TREITZ. Hernia retroperitonealis, ein Beitrag zur Geschichte innerer Hernien. Prague, 1857.
96. VAN HOLST. Upsala Läkaref. Förh., 1911–12, xvii, 263.
97. VAUTRIN. Rev. de chir., Par., 1907, xxxv, 46.
98. VOGT. Monatschr. f. Geburtsh. u. Gynaek., 1913, xxxvii, 817.
99. WAGNER. Fortschr. a. d. Geb. d. Roentgenstrahlen., xxiv, 40.
100. WALDEYER. Hernia Retroperitonealis, nebst Bemerkungen zu Anatomie des Peritoneum. Breslau, 1868.
101. WALLACE. Buffalo M. J., 1910–11, lxvi, 300.
102. WEIL. Ztschr. f. aertzl. Fortbild., 1913, x, 417.

* The asterisk indicates references not in Moynihan's bibliography.

OBSERVATIONS IN ONE HUNDRED SEVENTY-FIVE CASES OF PYELONEPHRITIS[1]

By W. CALHOUN STIRLING, M.D., Winston-Salem, North Carolina
Genito-Urinary Surgeon, Lawrence Clinic

IN this report, the discussion will include those cases of renal infection caused by organisms other than the tubercle bacillus. No mention will be made of malignancy. In reporting any series of cases, it is well to limit the discussion to some specific entity, and it has been my endeavor to confine this discussion to the etiology, diagnosis, and treatment of pyelonephritis.

It is only since the advent of the cystoscope that the diagnosis and treatment of renal infections have been taken out of the realm of uncertainty and put on a firmly established basis. Before the cystoscope was used, we had to rely on clinical symptoms, on urinalysis, and occasionally on the X-ray findings, and, if the occasion justified it, an exploratory operation was done to determine the exact pathology. With the present armamentarium at our command, an exact diagnosis may be made and it may be definitely determined whether the lesion be in the upper or lower urinary tract.

The sole brief held for this discussion is to emphasize again the absolute necessity for making more careful and guarded diagnoses of intra-abdominal as well as kidney lesions. To rule out the urinary tract in a surgical infection, without making an exhaustive examination of the blood, urine, and, if necessary, the fæces, is to court disaster. No apology is made that this series of cases is seen solely from the urologist's standpoint, or through a cystoscope, as sometimes is whispered along the side-lines, for in every case a careful examination has been made both by myself and Dr. C. S. Lawrence. A report from the laboratory has been studied in every case, including a total leucocyte count, blood smear, hæmaglobin estimation, and an examination of the excreta, if necessary. It is only by collaboration of the general surgeon and urologist that these infections can be solved.

The literature contains enough corroborative evidence to satisfy even the most skeptical, regarding cases of wrong diagnosis. Urinary infections are with us, and just so long as we dismiss them lightly or explore the abdomen without determining the offending organ, then just so long are we going to have a persistent postoperative train of symptoms.

In this series of 175 cases of pyelonephritis admitted to the Lawrence Clinic and treated, 29 per cent gave a history of an intra-abdominal operation with no relief of the pain and other symptoms. Reports bearing out this statement, could be cited from any large clinic, showing that we are too prone to rush in without carefully working up our cases.

The youngest patient seen was 24 months old, the oldest 84 years old. The average age was 39 years. The number of females was 115, while 60 males were affected. One reason why more females are affected is doubtless due to the lack of drainage because the generative organs encroach on the urinary tract. This was recently emphasized in a primipara who entered the hospital complaining of nausea, vomiting, and severe pain in the right side. She had a high temperature and was very toxic. A cystoscopic examination was done. A ureteral catheter was passed to the right kidney and a pyelogram made. The pyelogram showed a constriction at the brim of the pelvis, produced by pressure of the gravid uterus against the pelvic brim, causing an obstruction, which resulted in a marked dilatation of the ureter above that point, producing a hydro-ureter and stasis in the kidney pelvis. An indwelling ureteral catheter did not relieve the symptoms sufficiently to warrant its use for a long period of time, so the uterus was emptied and the patient made an uninterrupted recovery.

ETIOLOGY

The common causes of this disease are:

1. Focal infections, including the teeth, tonsils, sinuses, skin, etc.,
2. Angulations of the ureter;

[1] Read before North Carolina State Medical Society, Asheville, North Carolina, April 18, 1923.

3. Nephroptosis;
4. Infection from adjacent structures;
5. Stenosis of the ureter due to pressure or from external processes, such as gravid uterus, adenoma of the prostate, etc.;
6. Calculi.

It was found that 50 per cent of this series had definite infection in the tonsils demonstrated on removal. It is a common occurrence for a patient to complain of an exaggeration of the kidney symptoms following tonsillectomy. There are cases where the tonsils served only as a portal of entry, not causing any local symptoms, but on removal, cleared up the renal pathology. We have repeatedly removed tonsils which contained pus but causing no pain in the throat, proving that we should be very wary about saying, "Oh, there is nothing the matter with your tonsils." Rosenow has definitely shown that duodenal ulcer, cholecystitis, appendicitis, and many other pathological processes are the result of foci located in the tonsils.

The teeth have been silent but very potent factors in certain of these cases, as 21 per cent were found to have abscessed teeth, demonstrated by X-ray or on examination of the teeth after removal. As high as seven abscessed teeth were seen in a woman with pyelonephritis with no pain whatever referred to the teeth, her infection persisting until they were removed, with no recurrence later. Pyorrhœa pockets alongside the teeth also may initiate this condition. In 7 per cent of the cases we were unable to find any definite focus of infection, possibly obscure lesions in the skin or bone.

The sinuses may also cause trouble though no definite pathology located in the sinuses was seen in any of these cases. The colon, gall bladder, and appendix, may also harbor organisms having a predilection for the kidneys, so that in treating these conditions, all of these potential causes must be eliminated before we can promise a patient a permanent cure.

Angulations of the ureter, ptosis of the kidney, ureteral stricture, and lack of drainage due to pressure from without, may cause pyelonephritis, well illustrated by cases of prostatic adenoma causing back pressure and stasis of the urine in the kidney with systemic absorption. Two of these cases required nephropexy to remove the symptoms, both kidneys being as low as the pelvic brim. Ureteral stricture has been found present in 4 per cent showing that this also must be considered in infections of the upper urinary tract. Hunner maintains that stricture of the ureter is the chief cause of pyelonephritis, but this view is not largely accepted, nor do we accept this as a primary etiological factor.

The methods of infection are usually considered as follows:

1. Hæmatogenous,
2. Lymphogenous,
3. Direct continuity,
4. Ascending along the ureter.

The concensus of opinion is that the vast majority are hæmatogenous, excepting the cases resulting from abnormal position of the kidney, lack of drainage, calculi, etc.

Volumes have been written about the offending organism in this disease but the chief bacteria found are the streptococcus, staphlococcus, and colon bacillus, the two former being found to be the chief sources of infection in this report. The pyogenic cocci are short-lived and usually are not demonstrable in the process they initiate, while the colon bacillus, being a secondary invader, as a rule, causes a purulent discharge, and is easily found in the urine. If a careful search is made, the streptoccus may also be found, though the colon bacillus usually outgrows and literally crowds it out. What is usually seen is the end-result and not the exciting cause. The colon bacillus usually is found where the infection is not blood-borne.

DIAGNOSIS

I think it is safe to say that the majority of surgical infections can be either definitely proven to be in the kidney or not. This being true, then it rests with us, as diagnosticians, to eliminate the kidney before exploration of the abdomen is justified. While 74 per cent of this series complained of pain in the affected side, pain and tenderness are unreliable signs. Radiation and juxtaposition of the abdominal contents make these signs unreliable. Muscle

spasm is of significance, and as a rule, is present in peritoneal infections. The temperature in acute kidney infections is usually higher with a lower pulse rate and frequently a chill at the onset. The leucocyte count is higher where the peritoneum is involved, rarely as a rule, in kidney infections, being over 15,000 to 18,000 white cells. Nausea and vomiting are usually present in abdominal infections, less so in kidney ones. Too much dependence should not be put on localization of an abdominal mass by palpation. The following case illustrates this point:

A man, age 33, entered the hospital March 22, 1922, complaining of a tumor mass in the left hypogastric region, freely movable and tender on pressure. The mass was the size of a large grapefruit, and could be freely moved into any other part of the abdomen. The history revealed the fact that he fell off of a wagon striking on buttocks, temporarily stunning him, but he was able to get up in a few minutes and resume his occupation. He had no further symptoms until 3 weeks ago, when the tumor had become so large that it interfered with his work. Physical examination was made but on account of the difficulty in localizing this mass, cystoscopy was done, and a pyelogram made of the kidney, which showed the mass to be attached to the lower pole of the kidney; on removing the organ it was found to be a hæmorrhagic cyst within the capsule. His recovery was uneventful.

Of this series, 13 per cent had postoperative pyelonephritis showing that it is quite common as a sequela of pus in the abdomen and also that it is frequent that these two conditions may co-exist (at the same time) and one serve as the cause of the other, and only by relieving both the infections can we stop this vicious circle. Of the 175 cases, pain in the affected side was present in 74 per cent, while dysuria and frequency was present in 50 per cent, varying from a slight frequency to very urgent tenesmus. Hæmaturia was seen in 16 per cent while 10 per cent had pain referable to other organs. Seventy-one per cent had bilateral pyelonephritis, 20 per cent were on the right side with nine on the left. Five cases had atrophic pyelitis, with marked diminution of the pelvic capacity. This condition is very obstinate. This process is diagnosed by a pyelogram after it is found that the pelvis does not hold as much as it should, i.e. from 5 to 8 cubic centimeters.

In any case where doubt exists, it requires but a few minutes to pass ureteral catheter to the kidney and definitely establish the status of the kidneys. Preliminary narcotization and gentleness in passing the instrument will obviate most of the pain incident to cystoscopy; so let me urge you to avail yourself of this aid in helping to solve every doubtful case.

A diagnostic point of much importance, is hammer percussion over the suspected kidney, pain being elicited in 90 per cent of the cases, varying with the degree of involvement of the kidney. In the diagnosis of appendicitis, beware of chronic pain in the right side with no acute flare-ups, also consider carefully a diagnosis of appendicitis made with the X-ray with no outstanding abdominal symptoms. Urinary findings may be both helpful and misleading; a single negative urinalysis may lull one into a false sense of security because of temporary lack of drainage caused by a plug of mucus, so that whenever possible a 24-hour specimen should be examined.

In a recent paper by the writer, attention was called to the fact that, in a series of 1000 autopsies, 20 per cent showed definite inflammatory changes present in the kidney, and of more significance was the fact that they were entirely overlooked in the determination as to the cause of death. Rather a high percentage of error.

Eight patients in this report passed stones as a result of cystoscopic manipulations. Twenty per cent of these stones were overlooked by the X-ray. Braasch, Cabot, Hall, and others report from 9 per cent to 20 per cent of ureteral stones not demonstrable by the X-ray, so that it is necessary in all cases where there are red blood cells in the urine to pass a wax-tipped catheter to the kidney and on withdrawal, to examine it for scratch marks. Keyes has devised a simple technique for passing a waxed bulb through the ordinary cystoscope, and is of the opinion that calculi may be found by this method that would otherwise escape notice. The term "essential hæmaturia" has given way to scientific diagnosis, and if the case be carefully worked up, we will find it unnecessary to hide our ignorance behind this meaningless term.

McNider, Payne, and others have shown that many of the so-called "essential hæmaturias" were the result of infections about the collecting tubules, resulting in scar tissue which interfered with the return blood supply causing congestion and rupture of the papillæ with hæmorrhage.

This pathological process may be the primal factor where tumor, calculi, infections, stricture, pyelitis granulosa, trauma and tuberculosis are ruled out. With the aid of a pyelogram or ureterogram together with the renal function and blood retention tests, a positive diagnosis can usually be made.

Several years ago John B. Murphy stressed the importance of obtaining an accurate history and making careful examination, paying close attention to the sequence of the symptoms as they appeared. The careful surgeon will correlate and make his deduction from the above enumerated findings and if this is done, there will be a great reduction in the number of cases of mistaken diagnosis and unnecessary abdominal explorations.

TREATMENT

In attempting to clear up renal infections, several factors must be considered. Conservative treatment in the past has not properly solved the problem, *per se*, as the etiological element was not considered. While we all advocate rest in bed, fluids, urinary antiseptics, and dietary measures, we must not lose sight of the fact that in many instances, the patient's life is at stake, and recent experience has taught us that more radical procedures are indicated and necessary. The treatment will, therefore, include:

1. Supportive measures,
2. Elimination of focus,
3. Cystoscopy,
4. Correction of any mechanical defects.

Supportive treatment will include hospitalization, with rest, forced fluids and the administration of some urinary antiseptic, and if necessary, a sedative, for the pain incident to the passage of a plug of mucus through the ureter is just as severe as that caused by a stone, for it is the sudden blockage of the ureter with distention of the kidney pelvis that causes such intense pain. Mixed vaccines in certain cases, may prove helpful but should not be depended on entirely. We have found that failure to eliminate the causative agent will fail to cure the patient permanently, and this fact is well illustrated by the fact that several patients who refused to have their tonsils removed even though the kidney was repeatedly lavaged, still complained of their symptoms, but later, after removing the cause, they promptly got well.

I recall a case where it was necessary to withdraw seven abscessed teeth before the patient got entirely well. Frequently, because patients do not have toothache or tonsillitis, it is hard to convince them of the necessity of an X-ray of the teeth and perhaps the extraction of several silent abscessed teeth or removal of tonsils to cure them.

It requires all the patience of the physician at times, to handle some of these patients who say, "Why Dr. So and So said that tooth is as sound as a dollar," when we tell them it should be extracted or, they say, "Dr. So and So said my tonsils were all right,"—a very broad statement for a physician to make from a superficial examination of the throat. More than one prominent otolaryngologist has said that he had never seen a normal pair of tonsils. If the focus be elsewhere, diligent search and elimination will reward the effort.

With the aid of the cystoscope, the exact pathology can usually be determined, and by passing a catheter to the kidneys, surgical drainage is established just as much as a tube drains an abscessed appendix. It has been found that silver-nitrate is most efficacious in clearing up pyelonephritis. It does not merely localize itself in the pelvis, but Weld has shown that this antiseptic penetrates the tubules as far as the glomeruli, sterilizing the entire tract. Mercurochrome gives fairly good results but silver-nitrate causes an erosion of the epithelial layers of the pelvis, thus allowing sterilization of the underlying tissues. The pelvis should be distended to the point of fullness, not pain; otherwise, the results are not so beneficial. Experience will obviate the necessity of using any special apparatus to determine the pressure of the injected fluid; an ordinary 20 cubic centimeter Luer syringe will answer all purposes.

In conditions where hæmaturia is present, 5 per cent silver-nitrate may be used with impunity, and will usually stop the bleeding unless the cause is specific. If a stenosis of the ureter is present, it will be necessary to dilate it and establish free drainage. We make it a practice to dilate all ureters to No. 11 F., thus insuring free drainage. If present stricture of ureteral orifice may be relieved by cutting it with scissors and then dilating it.

In correcting mechanical defects, it is necessary to consider such conditions as ptosis of the kidney causing kinks in the ureter, pressure on the ureter by an abdominal viscus, adenoma of the prostate, etc.

In selected cases of hydronephrosis a plastic operation on the sac may benefit certain cases a great deal; occasionally in pyelonephritis of pregnancy it will be necessary to empty the uterus, but an indwelling ureteral catheter should be tried and, if necessary, continous pelvic lavage instituted.

In this series, only one surgical kidney was seen, an acute fulminating streptococcus pyonephrosis, which required nephrectomy. By draining the kidney with a catheter and promptly eradicating the cause, we will, in the majority of cases, save the patient an operation. Our records show 94 per cent cures, where patient consented to complete eradication of focus and continued treatment until specimen was free of pus and culturally negative.

CONCLUSIONS

1. A very careful examination of the urinary tract should be made before one is justified in opening the abdomen.

2. Of this series 29 per cent had an abdominal operation which did not relieve the patient at all.

3. Pyelonephritis is being constantly overlooked as well as dismissed lightly by the medical profession, and as long as this is true we will continue to fail to cure a large number of cases.

4. A diagnosis can usually be made by an examination of a 24-hour specimen of urine and, if necessary, by a cystoscopic examination, ureteral catheterization, and by pyelogram if in doubt.

5. The treatment consists not in conservative methods but in the elimination of the focus of infection, lavage of the kidney pelvis, and dilatation of the ureter with the correction of any mechanical defects which may be present.

BIBLIOGRAPHY

CAULK, J. R. Differential diagnosis between kidney and intra-abdominal lesions. South. M. J., 1922, xv, 49.

HUNNER, GUY. Conservative renal surgery associated with ureteral stricture work. J. Urol., 1923, ix, 97.

STIRLING, W. C. Pyelonephritis. J. Urol., 1922, ix, 29–36.

Idem. The cystoscope in the field of urology. South. Med. & Surg., 1922, Dec.

MAGOUN, J. A. H. Pelvis of kidney as a possible source of infection of the blood stream; a preliminary report. J. Am. M. Ass., 1920, lxxxiv, 73–75.

MCNIDER, W. B., and PAYNE, R. L. Surgical problem of unilateral symptomless hæmaturia. J. Am. M. Ass., 1916, lxvii, 1918.

KEYES, E. L., JR. The wax-bulb ureter catheter for routine use. J. Urol., 1920, iv, Dec.

ROSENOW, E. C. Elective localization of streptococci. J. Am. M. Ass., 1915, lxv, 1787, 91.

HALL, J. and T. D. The cystoscopy in the diagnosis and treatment of disease in the urinary tract. M. J. Tennessee, 1917, Aug.

UNILATERAL URETERAL INJURIES[1]

By LEON HERMAN, M.D., Philadelphia

TRAUMATIC injuries of the ureters are exceedingly rare; operative wounds relatively common. The literature of ureteral wounds has developed within comparatively recent times in keeping with the rapid development of modern surgery. The Wertheim operation for cervical cancer has been productive of more ureteral surgery than any other operative procedure, probably not excluding intentional injuries done during the course of bladder operations.

Several instances of ureteral injury have come to our attention during the past 2 years, each one of which will serve as a text for the discussion of an important phase of our subject. So rarely does the surgeon meet with these cases that he must rest content with a knowledge of the experience of others and bide that time when this knowledge will aid in the difficult solution of the problem presented by a ureteral injury occurring in his own practice.

FREQUENCY

The majority of traumatic wounds of the ureter involve the lumbar or abdominal segment: accidental or operative wounds involve chiefly the pelvic portion of the tube. In 1902, Maubert collected 30 cases of surgical injury of the ureters; Oeconomos in 1921 found 159 cases reported; T. S. Burr mentions a series of 630 hysterectomies for carcinoma in which the bladder was injured 19 times, a single ureter 10 times, the bladder and one ureter, 3 times, and both ureters one time; Sampson reported 32 injuries occurring in 1095 pelvic operations, 19 of which complicated operations for uterine cancer; Kayser collected 29 cases of ureteral injuries, 26 of which complicated the Wertheim operation.

This writer quotes Wertheim as having had 49 (10 per cent) of ureteral injuries in a series of 500 hysterectomies, of which only 9 were intentional.

Reuben Peterson's paper gives the detailed account of 72 cases of uretero-ureteral anastomosis, the majority of which were primary repairs of surgical injuries. In a paper by the author in 1922, there were tabulated 24 instances of bilateral ureteral injury to which may be added 4 additional cases, one reported by Crabtree, another by Laws, while Dr. E. E. Montgomery and Dr. Edward Schumann have each had a case of bilateral ureteral ligation. Dr. Montgomery's patient was reoperated upon when it was found that the ureters had been ligated and cut. Bilateral ureterovesical anastomosis was done and the patient survived for about a year when she died from recurrent carcinoma. Dr. Schumann's case is most remarkable in that the patient has survived double ureterovesical anastomosis and is apparently well 12 years after operation. Barney, in 1910, could collect only 20 authenticated instances of the intraperitoneal injury of one ureter.

The foregoing figures are impressive of the fact that while ureteral injuries are not uncommon, it is likely that in many more instances the injury is not reported, or that the patients die without recognition of ureteral injury as the cause.

CLASSIFICATION

Bilateral:
- Traumatic
- Operative (accidental)

Unilateral:
- Traumatic
- Operative (accidental)

Bilateral traumatic injuries—none reported in literature.

Bilateral operative (accidental) injuries.
- a. Bilateral ligation
- b. Kinking by ligatures
- c. Occlusion by vaginal clamps
- d. Occlusion by exudate following Percy cauterization
- e. One ureter severed; other ligated
- f. Segment removed from one ureter; other occluded by kinking
- g. One ureter kinked, other ligated.

Unilateral traumatic injuries.
- a. Stab wounds
- b. Gun-shot wounds
- c. Subcutaneous injuries

Unilateral operative (accidental) injuries.
- a. Ligation
- b. Unilateral division-intra-or extraperitoneal injury
- c. Excision
- d. Instrumental rupture (catheter)
- e. Crushing with clamps
- f. Perforation with needle
- g. Lacerations, contusions, denudation.

[1] Read before the Philadelphia Urological Society, February, 1923.

UNILATERAL TRAUMATIC INJURIES

Subcutaneous injuries of the ureters may be classified among the curiosities of surgery. Morris collected 24 cases of which he considered only 3 to have been verified; 4 were classified as probable and 5 as possible; 12 were rejected as not even probable. One of the verified cases, that of MacKenzie, was intraperitoneal. Keyes accepts MacDonald's case as authentic.

The following case history is submitted, not with the claims of absolute authenticity, but in the belief that we were dealing with lacerations of the ureter complicating fracture of the pelvis.

Unilateral traumatic injury of the ureter complicating fracture of the pelvis, with lacerations of the prostatic urethra.

Adult male, admitted to the Methodist Hospital of Philadelphia on the surgical service of Dr. James Baldwin in 1922. Seen in consultation with Dr. Baldwin some hours after the accident. Patient had passed some bloody urine and there was slight spontaneous bleeding from the urethra. The patient's condition was satisfactory. Cystoscopic examination showed lacerations in the prostatic segment of the urethra with considerable bleeding. Blood was seen issuing from the orifice of the left ureter. The right ureter was patulous and apparently normal. The left ureter was obstructed at the level of the sacro-iliac joint and manipulations of the catheter seemed to increase the bleeding. It was impossible to insert the catheter beyond this point of obstruction. There were no symptoms pointing to renal injury so that it was decided to treat the case expectantly. Subsequent X-ray studies showed fracture of the ilium extending through the left sacro-iliac joint and fracture of the descending ramus of the pubic bone. The patient was kept under observation by Dr. Baldwin and the writer during an uneventful convalescence. No further urological examinations were made.

F. T. Brown reports a case of subcutaneous rupture of the pelvis of the ureter which is, so far as we know, absolutely unique in surgical writings.

F. T. Brown. Traumatic rupture of the pelvis of the right ureter.

Boy, aged 9 years, admitted to the hospital with the history of having been struck by a car. There seemed to be an injury on the left iliocostal region. Several ounces of bloody urine were removed by catheter. He recovered, but a tumefaction appeared in the right loin which was thought to be a hæmatoma. After 3 weeks he was discharged from the hospital but reapplied for admission after several days complaining of pain in the right loin, swelling of the abdomen, and vomiting. There was bulging in the right flank and a fluctuating mass was felt below the right costal margin anteriorly. Cystoscopy showed obstruction of the right ureter ¾ inches from the bladder. The cause of this obstruction was not determined. An incision was made in the flank and 36 ounces of bloody urinous fluid was evacuated. The kidney was apparently normal. The operation was followed by a persistent urinary fistula and 16 days later the kidney became tender and systemic symptoms appeared. Nephrectomy was done, and on examination there was found a rent in the pelvis of the ureter ¼ inch in length and situated about 1½ inches from the kidney.

Gunshot and stab wounds of the ureter are likewise extremely rare. It is a surprising fact that the surgery of the war has added but little information on the subject. Many ureteral injuries were doubtless overlooked when in association with extensive and fatal visceral injuries, and many also have no doubt gone unreported. According to Oeconomos, only 15 cases have been described and none of these as bayonet, sword, or dagger wounds.

In calling attention to the rarity of war wounds of the ureter, Oeconomos takes occasion to mention the remarkable case of Zaayer in which the ureter was punctured by an iron picket. The patient, a child of 9 years, fell upon an iron picket fence, one of the points entering the abdomen and perforating the ureter. The extravasated urine came away through the abdominal wound without signs of peritoneal infection. Nephrectomy resulted in complete cure.

In Vaughn's classical case of gunshot wound of the ureter, the symptoms of peritonitis appeared after a week, but at operation no visceral injury was found. Thereafter urine discharged from the abdominal incision and from the wound of exit of the bullet in the back. Three months later the obliterated lower end of the ureter was exposed, and after dissecting free the upper dilated segment, a ureterovesical anastomosis was made successfully. Barney's patient had four perforations of the small intestine in addition to complete severing of the ureter. Death followed as the result of peritonitis, but at autopsy the peritoneal cavity was free from urine, nature

having sealed off the ureter. There are other cases of stab and gunshot wounds of the ureter scattered through the literature, the majority of which have been quoted again and again and need not be discussed here.

With this brief reference to traumatic injuries, we will proceed with the discussion of the far more important subject, namely operative injuries of the ureters.

ETIOLOGY

Operations on the pelvic organs in the female are the most common, but by no means the only source of accidental ureteral injuries. Congenital or acquired malposition of the ureters offers a predisposition to injury during operation in areas so remote as the hernial orifices.

Ross and Taylor discussed this particular accident several years ago and reported an interesting case. Corliss in 1904 collected 11 cases, 6 of which were inguinal and 5 femoral. The hernial sac usually contains a portion of the bladder wall as well as one ureter, usually the right. The latter is almost invariably dilated as the result of congenital atresia of the orifice, the dilatation preceding its displacement in the sac. The dilated thin walled or badly infected ureter contained in the hernial sac is usually opened by the surgeon in the belief that he is dealing with a diverticulum of the sac, a cyst of the cord, or a mass of enlarged veins. The ureter usually drains an infected or functionless kidney and calls for nephrectomy in the majority of instances.

Rupture of the ureter by the ureteral catheter probably occurs more frequently than the reported cases would lead one to believe. The normal ureter is extremely resistant to traumatism, but undue pressure with the catheter at the site of a stricture or area of ulceration due to stone may easily direct the instrument into the retroperitoneal space or even into the peritoneal cavity. Noble removed a ureteral catheter from the peritoneal cavity and sutured the rent in the ureter. The catheter had been used as a guide in attempting to remove a ureteral stone. During the extraperitoneal operation, the peritoneum was opened accidently and the catheter was found in the peritoneal cavity. The patient recovered.

Vaginal hysterectomy has had its toll of injured ureters, but more as the result of crushing by clamps than by ligation. As long ago as 1895, Tuffier was able to collect 40 cases of ureterovaginal fistula following this operation.

Ureteral occlusion has followed the application of the Percy cautery to the malignant cervix. Ureteral injury has never, so far as we know, been attributed to the action of radium on cervical cancers.

Voluntary ureteral injury is now done whenever the operator feels that the exigencies of the case demand it, and the success of anastomotic operations has removed in large part the fears concerning the final outcome.

When wounded inadvertently, the ureteral wound is likely to escape detection during the primary operation but if the discovery is made, repair may be done in many instances with no greater difficulty than in cases of intentional injury. The majority of accidental injuries, however, are not discovered at the time of operation and with the development of complications, the necessity for operative repair arises. While the late results of ureteral injury have served in some measures to teach us the proper method of dealing with injuries discovered early, nevertheless each case remains more or less a law unto itself.

Under all circumstances, much depends upon the site and nature of the injury, the previous state of normalcy of the kidney and ureters, the gravity of the primary operation, the condition of the patient, the time that has elapsed since the primary operation, whether the injury is unilateral or bilateral, and whether the injury is intraperitoneal or extraperitoneal. Bilateral injuries other than occlusion are rare; these we have discussed elsewhere and will limit our remarks at this time to unilateral injury.

THE SITE AND NATURE OF THE INJURY

With a few rare exceptions, accidental wounds of the ureter are so situated that anastomosis of the ends of the tube or intra-

vesical implantation is feasible, though not necessarily expedient.

The vast majority of such injuries are brought into an extraperitoneal position with the peritoneal repair incident to the primary operation and can be classified as intraperitoneal only when urinary extravasation occurs into the peritoneal cavity. Intraperitoneal injury of one ureter is known definitely to have occurred in 20 instances, most of the patients having recovered with the development of fistula through the original abdominal incision. Barney has called attention to the fact that the peritoneum of man occupies a place midway between the carnivora and the herbivora in its reaction to sterile urine, in that like the herbivora it shows a marked resistance to the irritating effects of extravasated urine. In the absence of pre-existent ureteritis or pyelonephritis, intraperitoneal division of the ureter rarely leads to generalized purulent peritonitis, the ureter quickly becoming occluded by blood clots and exudate; or, if leakage continues, the urine finds exit at the abdominal incision. Ureterovaginal fistulæ commonly follow ureteral injuries, but these must be looked upon as extraperitoneal in the majority of instances.

The nature of the injury varies from simple contusion, which one could scarcely hope to avoid in hysterectomy, to the tearing away of large segments of the tube. This latter occurred together with traumatic rupture of the iliac artery and vein while Werder was attempting the removal of a 12 pound sarcoma of the ovary.

The various operative ureteral injuries may be tabulated as follows:

a. Partial section,
b. Complete section,
c. Removal of segments of various lengths,
d. Denudation,
e. Destruction of nutriment vessels and nerve supply,
f. Ligation,
g. Crushing with clamps.

The accumulated clinical and experimental data relative to ureteral injuries lead to certain therapeutic generalizations that will probably stand the test of time. In the primary repair of the completely severed ureter, where restoration of the continuity is possible, the choice lies between ureteroureteral and ureterovesical anastomosis. In adopting the former, one presupposes the possiblity of end-in-end anastomosis which, as Peterson has shown, is vastly superior to all other methods. I think it is safe to say that when this method is impracticable, uretero-ureteral anastomosis should be discarded in favor of some other procedure. Furniss champions bladder implantations, and denies the allegation that the new ostium soon contracts with destruction of the kidney. He reports two cases in which the functional results were excellent, in one instance the attendant pelvic distention decreasing. Furniss advocates the method in cases of double ligation if, after removal of the ligatures, the vitality of the ureteral walls seems to be impaired. Kroenig reports two cases of primary double anastomosis in one of which both kidneys were functioning well 2 months after operation. The successful cases of bilateral ureterovesical anastomosis of Montgomery and of Schumann have been mentioned.

Two additional instances of late double anastomosis for ureteral injury have been recorded; Werder's patient developed a recurrent fistula which was corrected by colpocleisis; Pinkham's case resulted in a primary success.

Unilateral ureteral injuries discovered during the primary operation which cannot be corrected by anastomosis operations are best handled by ligation of the proximal segment, provided the ureter is not infected and provided also that there is a healthy kidney on the opposite side. When the opposite kidney is functionally poor and anastomosis of the severed tube is impossible, the upper segment must be implanted in the bowel or its end brought to the skin surface. In the event that the ureter is badly diseased or drains a badly infected kidney, an immediate uretero-nephrectomy is indicated, provided the condition of the patient warrants it; otherwise the end of the ureter should be brought to the skin surface and nephrectomy performed later. This is a safer procedure than ligation of an infected ureter. The above rules are based on the considerable clinical

experience of Judd and many others, not only with accidental ureteral injuries but in bladder surgery, in which the disposition of one ureter is a frequent problem.

Anders Peterson reports 17 clinical cases of unilateral ureterovesical anastomosis of which 4 were examined later and the ureter was found to function normally. Kroenig reported 9 cases operated upon for ureterovaginal fistulæ with bladder implantation of the ureter. These patients were cystoscoped from 5 months to 1½ years after operation and in 5 the transplanted ureter functioned normally, while 2 showed stenosis with slight hydronephrosis. Peterson did 24 dog experiments either by the Coffey, Stiles, Mann or Furniss technique with 80 per cent of successes and 20 per cent of failures from stenosis, pulling out of the ureters and infection. Wertheim is credited by Kayser with 100 per cent of success in 7 primary operations and with four successes out of five attempts at the repair of ureterovaginal fistulæ by ureterovesical anastomosis. From the Mayo clinic comes the report of 21 clinical cases of ureterovesical implantation, 17 of which were cystoscoped from 18 days to 4½ years after operation; in 5 the kidney had ceased to function, but in all of these the ureter had been anastomosed under great tension. Eliminating these, the normal kidneys were 75 per cent, the fair functioning kidneys, 25 per cent.

There are four deaths in the series from operation—all cancer cases. It is advised that the ureter be ligated when great tension is necessary to bring the bladder and ureter together; otherwise anastomosis may be done with every chance of success. Judd believes it is a safer procedure to ligate a hydro-ureter than to implant it.

One must conclude from the data at hand that ureterovesical anastomosis is a satisfactory procedure in selected cases.

Ligation of an uninfected ureter may cause the silent death of the kidney; it may cause pain demanding nephrectomy; it may give rise to secondary infection of the kidney, or ureteral necrosis may occur at or above the site of obstruction, giving rise to fistula deformation or peritonitis, or in rare instances the ureteral lumen may be restored as a result of absorption of the catgut before kidney destruction has taken place. Barney's figures indicate that ureteral ligation is not so innocous a procedure as some maintain. In one of his cases of single ligation the patient died after 36 hours from uræmia with urinary suppression. In a similar case reported by Robinson, the patient recovered after decapsulation of the kidney on the non-obstructed side. The writer has recently seen a case of hydronephrosis following unilateral ureteral injury in consultation with Dr. Damon Pfeiffer, of Philadelphia. This patient was referred to Dr. Pfeiffer for examination on account of pain and a mass in the right kidney region. The patient's husband, a physician, stated that a vaginal hysterectomy had been performed 14 years before. Immediately succeeding the operation, which was done by the clamp method, considerable pain was felt in the region of the right kidney. This pain persisted until the clamps were removed. The convalescence thereafter was uneventful and no abnormality of the kidney was suspected until some years later when an attack of acute infection again directed attention to this organ. At examination it was found that the ureter was obstructed at a point near the bladder wall, and that the kidney was entirely functionless.

Of Sampson's 10 cases of unilateral ligation, 6 recovered, one with hydronephrosis, the other 5 with renal atrophy. Barney failed to produce reflex anuria after single ligation in 36 dog experiments. In 21 per cent of the human cases an early decrease followed by a rapid increase in urinary secretion was noted. In two instances hæmaturia followed the ligation but was rapidly recovered from. Slight pain and tenderness in the renal area followed ligation in 26 per cent, necessitating nephrectomy in one instance. Renal infection occurred in 7 (15 per cent), and it was necessary to do a nephrectomy in every instance.

Barney states that the primary mortality of unilateral ureteral ligation is 17.8 per cent, and this together with the considerable morbidity succeeding the operation definitely contra-indicates the procedure in Barney's

opinion. The final answer to the question remains for the future to decide.

There is a similar difference of opinion regarding the changes that occur in the human kidney after ureteral ligation and also to some extent in the kidneys of experimental animals. Beer concluded after experiments on 60 dogs that aseptic ligation of the ureter leads to primary hydro-ureter and hydronephrosis, and after about three weeks shrinkage and atrophy of the sac begins; that after three or four months the kidney is represented by a small fibrous mass, but that in the presence of infection a large hydronephrotic sac results. G. D. Scott in 30 experiments found that typical hydronephrosis results in every instance, the degree depending upon the duration of the obstruction. He further states that complete permanent obstruction produces hydronephrosis more rapidly than incomplete obstruction. Guyon is in agreement with Beer having, found atrophy to succeed slight temporary distention. Cohnheim is of the same opinion. Pearce in experiments on dogs, Bainbridge working with cats, and Amos in ligations on rabbits and guinea pigs, produced hydronephrosis in practically every instance.

With experimental results so widely at variance, one could scarcely expect to find unanimity of opinion regarding the sequence of events in clinical cases.

Having discovered ureteral ligation at the time of the primary operation, the ligatures should be removed, and in 5 such cases reported by Sampson the convalescence was uninterrupted. In the absence of demonstrable injury due to the ligation which would promise future necrosis, deligation is unquestionably the proper procedure, notwithstanding that necrosis has been known to occur in certain instances. T. S. Burr reports a case of immediate deligation in which a vaginal fistula appeared after 3 days but closed spontaneously in several months.

Unilateral ligation discovered hours or days after the primary operation in the absence of fistula or other symptoms presents the most difficult of surgical problems. In the absence of symptoms and with a normal kidney on the opposite side it seems to me that honesty demands a frank statement of the accident, but that sound judgment would dictate inactivity.

Several cases of spontaneous rupture of a ligated ureter are recorded, one by Frankel, the other by Blumenfield. In Frankel's case the ureter had been sectioned and ligated; the ligatures cut through and the patient died of peritonitis. Blumenfield tied the ureter unintentionally and on the ninth day the ureter ruptured just above the point of ligation, causing fatal peritonitis.

Clinical symptoms arising from unilateral ligation are chiefly referable to the kidney and are caused for the most part by infection. Total ureteral obstruction may be due, not to encircling ligatures, but to inflammatory swelling or to kinking from ligatures placed in proximity to the duct. In these cases the problem is not the restoration of continuity of the urinary tract but the treatment of complications. In the majority of instances nephrectomy is necessary on account of infection of the kidney. In case of double ligation, the removal of the ligatures is the method of choice.

Traumatic interference with the nutrition of the ureter leading to necrosis is a more serious accident than ligation or even sectioning of the tube, provided these accidents are discovered at the primary operation. Crushing with clamps is likewise a serious accident. Furniss accidently clamped the ureter in two cases, the clamps remaining in position 7 or 8 minutes. In one a fistula developed in 8 days, in the other in 20 days. In both instances, the ureter had been dissected free for a distance of 3 centimeters at the site of application of the clamps. This is considered a contributing factor in necrosis to the extent that Furniss considers it an indication for immediate ureterovesical anastomosis. Sampson, however, mentions four similar cases which recovered without complications; in one case 17 centimeters of ureteral catheter were left in the ureter and the patient died after 7 days; in another instance an indwelling catheter was crushed by the clamp but the fragment was removed through a slit in the ureter and the patient recovered without complications; in still another case, a ureterovaginal fistula

developed but closed spontaneously in 3 weeks. In three cases the ureter was both clamped and ligated but released during the operation; one developed an obstruction which was relieved by catheterization; the others recovered without complications.

Harrington crushed the ureter in dogs with a Kocher artery forceps for from 1 to 30 minutes and then replaced the ureter behind the peritoneum; no leakage of urine followed.

Crushing of the ureter during labor is an infrequent cause of ureterovaginal fistula.

One is quite unjustified in drawing conclusions from such insignificant data, but our feeling is that the surgeon should be guided by the appearance of the crushed segment. If the tube is pulpified, natural restoration would scarcely be expected and anastomosis would be in order. In all cases some provision should be made for drainage, preferably through the vagina.

In one of Graves' cases in which the ureter was almost completely severed, he ligated the proximal end without evident interference with the patient's convalescence.

Secondary necrosis of the ureter following pelvic dissection is a rare complication. In experimental animals considerable trauma can be inflicted without secondary necrosis as shown in the experiments of Harrington and of Stewart and Barber. In 7 of Wertheim's clinical cases the sheath of the ureter alone was injured and two developed urinary fistulæ. Gaston Torrance reports a case of ureterovaginal fistula following a Wertheim operation in which the ureter had been dissected up to the pelvic brim but not incised. The condition was corrected by ureterovesical anastomosis. In the following case the inference is that the ureter had been pricked by a needle or possibly the wall partly included in a ligature. We have no explanation to offer of the closure of the fistula after catheterization but the case is not unique.

Unilateral ureteral injury complicating hysterectomy; ureterovaginal fistula; spontaneous closure of fistula following ureteral catheterization.

Mrs. H. M., 50, admitted to the Methodist Hospital of Philadelphia, service of Dr. Norris. Diagnosis: chronic metritis and endometritis. Operation: October 26, 1921, panhysterectomy—bilateral salpingo-oophorectomy. Small para-ovarian cyst on right side removed. Pathological diagnosis: chronic metritis and endometritis—Richardson. Postoperative: The operation was not difficult and the postoperative course was uneventful until the fourth postoperative day when the patient complained of a watery discharge from the vagina. During the first few days the output of urine was normal in quantity and quality. After the development of the fistula, the output of urine from the bladder was diminished in quantity but it was at no time abnormal either microscopically or chemically.

Examination November 15, 1921, showed no communication between the vagina and bladder or urethra.

Cystoscopy, November 28, 1921 (Dr. Herman). Bladder mucosa normal. No fistulous openings found. The left ureter obstructed to all catheters at a point 3 centimeters from the bladder, but the catheter drains normal appearing urine in a continuous flow. Right ureter patulous; normal urine in normal spurt.

Indigo-carmine (15 cubic centimeters) injected intravenously. Intense blue urine from the right catheter in 3 minutes; moderately blue urine from the left catheter and from the vagina in six minutes. After a period of 20 minutes a catheter was placed in the bladder and the urine obtained was not discolored.

Cystoscopic diagnosis: ureteral fistula (left) communicating with the vagina. The left ureter is obstructed to catheters but not to flow of urine at point 3 centimeters from the bladder. It seems likely that a small opening was made in the ureter or the latter injured at the time of operation, possibly by a needle.

Postoperative: The day following catheterization the flow from the vagina ceased and never recurred.

December 3, 1921. Phenolsulphonephthalein first hour—30 per cent: 2nd hour—15 per cent.

December 3, 1921. Discharged.

In all cases where the integrity of the ureteral wall has been jeopardized, drainage should be instituted, care being taken to avoid placing gauze in positions approximating the site of the ureteral injury.

In discussing the treatment of unilateral ligation discovered after operation and without symptoms, we advised inactivity for the reason that operative repair has a considerable mortality and with a normal kidney on the opposite side the patient's expectations of life are not seriously impaired or curtailed.

If implantation is to be considered, the longevity of the renal parenchyma in states of complete obstruction is of prime importance. Nature is most tenacious of renal function which may continue in dogs after 36 days of complete obstruction. Harrington found that

after 3 weeks' occlusion sufficient parenchyma persisted to justify implantation into the bladder. Barney mentions three cases of unilateral obstruction, in one of which the ureter was released after 6 days with restoration of normal function; in a second case the obstruction continued for 10 days and there was considerable hydronephrosis but the kidney continued to secrete clear urine for years after operation; success followed deligation in a third case after 5 days. Barney concludes that ureteral obstruction may persist for 10 days without material injury to the kidney, while Johnson has shown that the renal function may be restored to the normal in dogs whose ureters have been obstructed for no longer than 2 weeks. In Caulk's case of bilateral obstruction of 8 days' duration, nephrostomy resulted in cure.

From the foregoing it is evident that promptness in relieving the obstruction is of vital importance in these cases.

Excluding cases of ureteral injury discovered at the time of their receipt, the vast majority come to the attention of the surgeon because of postoperative complications of which the most important are urinary fistulæ. We have already quoted Barney to the effect that the primary mortality in unilateral obstruction is 17.8 per cent and that infection of the kidney necessitating nephrectomy occurs in 15 per cent.

It is impossible to give the comparative incidence of urinary fistulæ following the several types of injury but ligation is perhaps the rarest cause of fistula. There were 18 fistulæ in Barney's series of 29 cases of intraperitoneal injury of one ureter, most of them being of the uretero-abdominal variety, but of the total number of ureteral injuries, ureterovaginal fistula is the most common complication.

The development of a fistula may be the first indication of the ureteral injury or there may be preliminary symptoms referable to the kidney. Anuria from reflex suppression is unusual. The fistula developed in from 7 to 18 days. In Crosbie's case a mass appeared above the pubis 2 days after hysterectomy, and puncture of the posterior vaginal cul-de-sac brought a gush of urine. Subsequently, a right ureterovaginal fistula was corrected by nephrostomy and uretero-ureteral anastomosis.

DIAGNOSIS

The cystoscopist will find little trouble in localizing the site of the ureteral injury, nor will there be difficulty in locating the fistulous opening which occupies the vault of the vagina as a rule on the injured side. Not only is the ureter usually obstructed at the site of the injury but if the latter is at all extensive, the lower segment lacks peristaltic action and the sphincter is more or less paralyzed. The ureter may be obstructed to catheters at a certain point, but the distal segment and the ureteral sphincter are seen to function, while dyes injected intravenously appear in the bladder by way of the involved ureter, as happened in one of our cases. This indicates partial necrosis of the ureter and is of good prognostic significance.

After the preliminary examination in these cases a catheter is placed in the healthy ureter and plug of cotton in the vaginal vault. An injection of indigocarmine is given and its appearance is watched for from the catheter, from the involved ureter and from the fistulous opening. Prompt appearance of the drug from the catheter in the healthy ureter and delayed but equal appearance from the opposite ureter and from the fistula is diagnostic. If the suspected ureter shows no elimination there can be no question of the involvement of that side. Laws has reported what he believes to be an exception to the above rule. His patient had openings at each angle of the vaginal vault. The right opening was draining freely but no urine came from the left one. It was found that the right ureter was patulous and the left ureter obstructed at 4 centimeters. Clear urine was obtained from the right kidney, cloudy urine from the left ureter. Indigocarmine appeared in the vagina in 6½ minutes and immediately afterward from the right kidney and then from the left. On injecting indigocarmine into the right catheter it appeared in the vagina. This he looks upon as an exception to Kelly's rule, namely that the vaginal fistula is on the side of the obstructed ureter. It is possible that colored fluids injected into

the pelvis of one kidney might be absorbed and eliminated by way of the opposite kidney.

Having found the location of the fistula it becomes necessary to ascertain the functional state of the kidneys and the presence or absence of infection, for upon this determination depends the treatment. The longer the fistula has persisted the greater the degree of renal destruction as a rule, since all fistulous ostia have a tendency to contract and cause renal distention. Infection is of evil significance although not necessarily precluding transplantation operations.

REFERENCES

AMOS. J. Path. & Bacteriol., 1904, x, 65.
BAINBRIDGE. J. Path. & Bacteriol., 1906, xi, 421.
BARNEY, J. D. Ann. Surg., 1910, March.
BARNEY, J. D. Surg., Gynec. & Obst., 1912, xv, 290.
BEER, E. Am. J. Urol., 1912, viii, No. 4.
BLUMENFIELD. Muenchen. med. Wchnschr., 1898, xlv, 992.
BROWN, F. T. Ann. Surg., 1905, xli, 127.
BURR, T. S. Physician and Surgeon, 1902.
CAULK, J. R. and FISCHER, R. F. Surg., Gynec. & Obst., 1920, April.
CHUTE, A. L. Boston M. & S. J., 1917, clxxvi, 149.
CORLISS. Quoted by Ross and Taylor.
CRABTREE, E. G. Surg., Gynec. & Obst., 1922, xxxv, 733–742.
CROSBIE, A. H. Tr. New England Branch Am. Urol. Ass., 1919-1920.
FRAENKEL. Arch. f. Gynaek., 1901, lxiv, 438.
FURNISS, H. D. Am. J. Obst., 1918, lxxvii, 14–21.
GRAVES, W. P. Boston M. & S. J., 1917, clxxvi, 149.
GUYON. Ann. d. mal. d. org. génito-urin., 1892.
HARRINGTON, S. W. Arch. Surg., 1921, ii.
HERMAN, L. J. Urol., 1923, ix, No. 2.
JOHNSON. J. Exper. Med., 1918, vol. or p.
JUDD, E. S. J.-Lancet, 1920, xl, 6–9.
JUDD, E. S. and SISTRUNK, W. E. J. Am. M. Ass., lxxv, 1401.
KAYSER, H. Med. Press & Circ., 1915, n.s., xcix, 106.
KRONIG. Monatschr. f. Geburtsh. u. Gynaek., 1907, xxv, 120.
LAWS, GEO. Am. J. Obst., 1923.
MACDONALD. Am. J. Obst., 1914, lxx, 329.
MACKENZIE. Quoted by Morris.
MAUBERT. Quoted by Oeconomos.
MAYO. Quoted by Peterson.
MONTGOMERY, E. E. Personal communication.
MORRIS. Surgical Diseases of Kidneys and Ureter. London: 1900, ii, 332.
NOBLE, C. P. American Medicine (Phila.), Sept. 27, 1902, 501.
OECONOMOS. Gaz. d'hôp., Paris, 1921, xciv, 197–204.
PEARCE. Univ. Med. Bull., Phila., 1903.
PETERSON, ANDERS. J. Am. M. Ass., lxxi, 1885–1891.
PETERSON, R. Surg., Gynec. & Obst., 1920, xxxi, 132.
PINKHAM, E. W. Am. J. Obst., 1915, lxi, 916.
ROBINSON, A. L. Brit. M. J., 1915, n.s., xcix, 106.
ROSS and TAYLOR. Ann. Surg., lxxiii, 613–620.
SAMPSON, J. A. American Medicine, 1902, Nov. 1.
SCHUMANN, E. Personal communication.
SCOTT, G. D. Surg., Gynec. & Obst., 1912, xv, 296.
STEWART and BARBER. Ann. Surg., 1914, lx, 723–728.
TORRANCE, G. J. Am. M. Ass., 1912, lxx, 1376.
TUFFIER. Quoted by Oeconomos.
VAUGHN. Am. J. M. Sc., 1905, March.
WERDER. J. M. Am. M. Ass., 1902, xxxix, 360.
WERTHEIM. Quoted by Kayser.
ZAAYER. Quoted by Oeconomos.

THE TRANSPERITONEAL CERVICAL CÆSAREAN SECTION[1]

By LOUIS E. PHANEUF, M.D., F.A.C.S., Boston

THE term transperitoneal cæsarean section is a confusing one since, at the present time, it may refer to four different operations, or better, to four modifications of the same operation devised by four different operators, namely Kroenig, Hirst, DeLee, and Beck. Although they all have in common an incision in the cervix or the lower uterine segment, for the delivery of a child by the abdominal route, they differ somewhat in the disposition of the peritoneal layers after the closure of the uterine incision. DeLee has suggested the term laparotrachelotomy, and although the name is scientifically correct it has not been generally adopted; its use would result in the avoidance of a great deal of confusion. Some continental accoucheurs refer to the operation as the suprasymphyseal cæsarean section, while both American and European writers have referred to it as the low cervical cæsarean section.

EVOLUTION OF THE TRANSPERITONEAL CÆSAREAN SECTION

Since the early days of cæsarean section, the two main troublesome complications have been hæmorrhage and sepsis. Porro, of Pavia, in 1876, attempted to overcome these, and succeeded in doing so; but his method entailed the sacrificing of the uterus. In 1882 Saenger, by introducing a proper method of suturing the uterus, so improved the results of the classical operation that the Porro operation was relegated to its proper place, that is a method to be used for special indications in the presence of infection and neoplasms.

The method of uterine suture has passed through many stages, from the using of silver wire, silkworm gut, silk and linen to the present-day use of catgut; again, the uterus has been sutured in one layer, two layers, three layers, and four layers. Both interrupted and continuous sutures or a combination of them have been advocated. At the present time some writers are reviving the use of silkworm gut and linen as stay sutures in closing the uterine incision, thus tending to show that no method has been entirely satisfactory.

With the introduction of proper methods of suturing, the hæmorrhage from the cut edges of the uterine muscle has been largely controlled, so that, in present-day operating this condition is but rarely a troublesome factor.

The prevention of sepsis, however, has not shown such brilliant results and it is for this reason that numerous modifications of the classical operation have been devised for cases where infection was suspected but where one was reluctant to sacrifice the uterus.

The foremost authors in obstetrics are fairly well agreed that in the presence of a virulent infection the best results are obtained by the removal of the infected uterus; the present-day method differs from the Porro operation only inasmuch as the cervix is closed by sutures, covered with peritoneum and dropped back in the abdominal cavity, instead of being fixed to the lower angle of the incision. This means clean healing and a much shorter convalescence. It is further conceded that a virulent infecting organism, the streptococcus for instance, may find its way through the intact peritoneum and cause septic peritonitis even in a true extraperitoneal section.

A large group of cases with unrecognized disproportion between the pelvis and fetal head, come to us after many hours of labor, with ruptured membranes, and having had vaginal examinations in their homes. The disproportion may be such that a pelvic delivery is not feasible except by craniotomy on a living child. Although there may be no definite signs of infection, in the light of present-day knowledge, these cases are considered infected, or at least they are classified as presumably infected. In that type of case the classic operation is contra-indicated because of the danger of peritonitis.

[1] Read before the Obstetrical Society of Boston, April 24, 1923.

It is a well known fact that each hour of labor, each vaginal examination, and each hour that the membranes have been ruptured has a definite bearing on the morbidity and mortality of the classic cæsarean section. It is also well recognized that certain patients having fulfilled all the so-called textbook indications for this operation subsequently develop peritonitis. In the classical type of operation since the incision is made in the body, or contractile part of the uterus, the stitches, no matter how placed, must serve as hæmostatic as well as approximating sutures. For this reason they have to be tied rather tightly, and because of this a certain amount of pressure necrosis may result.

Since it has been possible to demonstrate the escape of lochia in the peritoneal cavity between the stitches, it is reasonable to presume that the bacteria which invade the puerperal uterus may find their way into the peritoneal cavity along the same channels, and since the peritoneal cavity is in no way protected from the uterine incision, peritonitis may be the result. This may explain the fact that peritonitis may sometimes develop in the so-called clean case.

The extraperitoneal methods have been largely developed in Europe, notably in Germany, and this because of the fact that so many of the patients coming to the Continental clinics are referred by midwives, the parturients being usually seen late in labor, after repeated vaginal examinations under poor aseptic conditions, and in such state that the classical operation is considered unsafe.

In 1907 Frank, of Cologne, described his operation for neglected cases. This consisted of a transverse abdominal incision, cutting across the recti; the peritoneum was separated from the bladder, and the anterior surface of the uterus, and enough of the lower segment was exposed for the delivery of the child. Later, this operation was modified by Latzko, Selheim, and others from the suprasymphyseal extraperitoneal operation into a suprasymphyseal transperitoneal section. The latter differed from the Hirst operation in that transverse instead of longitudinal incisions were made in the abdominal wall, the peritoneum, and the lower uterine segment.

Doederlein attempted to revive the operation of laparo-elytrotomy, which had been first suggested in 1823, and then taken up by Gaillard Thomas in 1871. Here the incision was made obliquely and parallel to Poupart's ligament. The incision offers easy approach to the pelvic connective tissue, and to the lateral portion of the lower uterine segment. After the incision of the lower uterine segment the child is delivered by forceps.

In 1915, Kuestner presented his method, which is a true extraperitoneal section, and reported 112 cases. Later, June, 1922, the same author reports 200 cases with two deaths.

In August, 1918, Markoe and McPherson published their article entitled "Extraperitoneal Cæsarean Section in Certain Infected Cases with the Carrel After Treatment." These authors advise the extraperitoneal operation in infected cases and describe their method, which is essentially that of Kuestner. Their results were excellent.

The above operations were true extraperitoneal sections, and probably offered the best means of protecting the peritoneal cavity. The disadvantages were that, not infrequently, the bladder and left ureter were injured with resulting fistulæ; second, the peritoneum was occasionally opened during its separation, thus losing the advantage of the extraperitoneal method; third, the pelvis had to be drained and this resulted in suppuration and long drainage in many instances; fourth, there was more hæmorrhage, since the incision in the lower segment had to be made to the side rather than in the median line, and the technical difficulties were greater; and last, the operation could not be repeated because of adhesions.

Kroenig brought a new light on the whole subject when he claimed that the better results obtained by this method were not due to the fact that the uterus was approached in an extraperitoneal manner but because the incision was made in the thin non-contractile lower segment rather than in the thick contractile body of the uterus. His operation consists of opening the abdominal cavity by a low longitudinal incision, separating the bladder from the uterus, making a longitud-

inal cervical incision, and after the extraction of the child, placenta and membranes, closing the uterine incision and completely covering it with the bladder by suturing the edge of the bladder peritoneum at a level higher than the upper aspect of the incision in the lower uterine segment.

In June, 1920, Barton Cooke Hirst described his technique in his *Atlas of Gynecology*, although he had previously brought his operation to the attention of the profession. He reported 30 operations on "almost certainly infected women" without a mortality. This operation is sometimes referred to as the Veit-Fromme-Hirst operation although in America it is known as the Hirst method.

DeLee, in June, 1919, presented his paper entitled "The Newer Methods of Cæsarean Section; Report of Forty Cases," before the section of obstetrics, gynecology, and abdominal surgery, at the seventieth annual session of the American Medical Association, at Atlantic City. This paper was subsequently published in the *Journal of the American Medical Association*. In this series of 40 cases performed by DeLee and his assistants there was no mortality. This author lays stress on the more comfortable convalescence and the absence of peritoneal shock and ileus. To quote him: "tympany and postoperative shock are decidedly less, and one gets the impression that a woman has suffered only a minor operation not the ordeal of the old cæsarean section." His technique is essentially his own modification of the Kroenig operation.

Cornell, in September, 1920, published his article, "The Cervical or Kroenig Cæsarean Section," in the *Illinois Medical Journal*. His observations confirmed those of DeLee.

In September, 1921, Beck described the "Two-Flap Low Incision Cæsarean Section" and reported 29 cases without mortality. He emphasized the fact that the operation was safe after an efficient test of labor.

In the same year (1921) E. Vogt, of Berlin, published his monograph "The Evolution and Development of the Suprasymphyseal Cæsarean Section." This is based on 183 operations performed at the Tuebingen Clinic, from 1908 to 1919. The author strongly advocates the cervical cæsarean section and believes that it has made the classical operation obsolete. He further believes that the intraperitoneal cervical cæsarean section is better than the extraperitoneal, because it is simpler technically, is free from injury to the neighboring structures, takes less time, and is less dangerous to the child when haste is imperative.

Polak and Beck, in May, 1922, illustrate the modified Kroenig cervical cæsarean section, in their article: "The Present Status of Obstetrics Referring to the Abuse of Cæsarean Section."

In June, 1922, Phaneuf and Hegarty described, in the *Boston Medical and Surgical Journal*, their methods of performing the Hirst and Kroenig cervical cæsarean sections, and reported their series of 40 cases. In this series 27 operations had been performed by Phaneuf and 13 by Hegarty. Of the 40 cases reported 33 were according to the Hirst and 7 according to the Kroenig technique.

Munro Kerr, in the *Journal of Obstetrics and Gynæcology of the British Empire*, 1922, xxviii, 475, compares the classical to the transperitoneal operation and states that the latter overcomes many of the difficulties of the former. He lays stress on the fact that there is less tendency to subsequent rupture if the incision is placed in the cervix, the noncontractile portion of the uterus.

In July, 1922, DeLee and Cornell in their paper "Low Cervical Cæsarean Section (Laparotrachelotomy)" report 145 cases with one death, and this in a woman very obese, with toxæmia, contracted pelvis, and days in labor. Death was from peritonitis on the fifth day. The authors state that this was a hopelessly neglected case that would have died no matter how delivered. DeLee in the *Practical Medicine Series* for 1922 reports 11 additional cases, or 156 cases with one death.

In the *Revue française de Gynécologie et d'Obstétrique*, Paris, xviii, No. 2, p. 33, January 25, 1923, P. Gaifami writes on the low transperitoneal cæsarean section and extols the advantages of section in the lower uterine seg-

ment. He describes 50 cases, several with beginning infection. The pregnant uterus was removed in one case 2 years later, and without the microscope no trace could be found of the incision. Conditions in the lower segment are more favorable for healing. In 11 cases the cæsarean section was repeated and the cicatrix was firm in all, even when the expectant treatment had been pushed to the extreme.

TECHNIQUE OF OPERATION (AUTHOR'S METHOD)

Hirst Operation

The abdomen is prepared and the patient is catheterized; she is then etherized and placed in a moderate Trendelenburg position. The operator stands on the left side as in the average pelvic operation; the incision which is median and about 5 inches long, starts at the symphysis and extends toward the umbilicus; the parietal peritoneum is opened in the median line, exposing the bladder and the lower uterine segment (intestines are practically never seen). The uterine peritoneum just above the bladder, where it is loosely attached, is incised to the uterine muscle; the index finger is introduced in the opening and the bladder is gently separated from the uterus; the finger is then directed upward and the peritoneum is separated from one side of the uterus. The procedure is repeated on the opposite side. The visceral peritoneum is then incised in the median line to within an inch of the upper limit of the incision in the parietal peritoneum, and the two layers of peritoneum-parietal and visceral-are united by carefully applied interrupted catgut sutures, about eight in number. We prefer the sutures to clamps as they are less likely to tear the peritoneum. The bladder is held under the symphysis by means of a retractor and a longitudinal incision is made in the cervix (an incision large enough to deliver an ordinary-sized child may be made entirely in the cervix, without encroaching on the corpus); the child is usually delivered by the vertex, using the obstetric forceps, if necessary, to assist in the delivery. Great care is used in making the incision in the thin cervix so as to avoid cutting the child's head. The placenta and membranes are extracted, a large strip of gauze is packed in the uterus, 1 cubic centimeter of pituitary extract is injected in the uterine muscle, and 1 cubic centimeter of aseptic ergot in the thigh. The cervical incision is closed with interrupted sutures of No. 2 chromic catgut, and the strip is removed before tying the sutures: the uterus is usually contracting well at this time. After sponging out the uterine incision, the peritoneal layers are further approximated by a continuous suture of No. 0 chromic catgut. As may be seen, the uterine incision is now entirely out of the general peritoneal cavity, and covered almost entirely by the bladder; the conjoined layers of peritoneum are united in the median line by two or three interrupted catgut sutures, and the abdominal wall is closed in layers.

The layers of peritoneum are adherent in the course of a few hours; uterine sepsis usually is apparent at the end of 24 to 48 hours, as shown by the rise of temperature and pulse, at this time, in infected cases. If infected lochia seeps through the uterine incision, it can be drained readily through the cervix, or through the lower end of the abdominal wound without coming in contact with the general peritoneal cavity.

Kroenig Operation

The patient is placed in the Trendelenburg position; the abdominal incision is made as in the Hirst operation; the visceral peritoneum is incised transversely where it is loosely attached just above the bladder, and the bladder is separated from the lower uterine segment; it is now held under the symphysis by a retractor and a longitudinal cervical incision is made within the denuded space; after the delivery of the child, the placenta and membranes are extracted, and the incision is closed with interrupted sutures of No. 2 chromic catgut; the bladder edge is drawn up so as to overlap slightly the upper edge of the transverse incision and then sutured to the uterus, with a continuous stitch of fine catgut, thus completely sealing off the uterine incision. The abdomen is closed in the usual manner.

The incision in the cervix is entirely covered by the bladder, and should infection occur,

drainage may be easily established through the cervix or by an anterior vaginal colpotomy.

Beck Operation

This differs from the Kroenig operation only in one respect, and that is in the fact that an upper flap of peritoneum is raised after separating the bladder. After the suture of the cervical incision is completed, the upper flap is brought down and anchored to the uterus by a few interrupted catgut sutures, thus covering over the upper part of the incision; the edge of the bladder peritoneum is then sutured, with a continuous stitch, in such a way that it overlaps the upper flap.

The claim made for this procedure is that it offers a stronger barrier to infection than does the original Kroenig operation. In doing the Beck operation we raise the peritoneum from the lower uterine segment in exactly the same way that we do in the Hirst operation, but we incise it transversely instead of longitudinally thus obtaining a superior and inferior flap instead of two lateral flaps.

In case of infection, drainage takes place through the cervix or the infected area may be reached by means of an anterior colpotomy.

DeLee's second contribution to the operation consists of uniting the fascia over the lower uterine segment by a continuous catgut suture, thus burying the cervical incision under this fascial layer. We have used this method in our last few cases.

PROTECTION AGAINST INFECTION OF THE PERITONEAL CAVITY

There are two points of view on this question: first a number of obstetric surgeons believe that in order to protect the peritoneal cavity, in a presumably infected case, the extraperitoneal route must be strictly adhered to; while others feel that in the presumably infected woman the transperitoneal route offers definite protection. To quote Hirst on the transperitoneal operation: "This method is comparatively simple; and the result has proved (in my experience) that it is reliable, preventing infection of the peritoneal cavity, especially during puerperal convalescence, which is the chief danger of cæsarean section upon the presumably infected woman, the infection of the endometrium in such cases spreading directly through the uterine wound to the peritoneal surface and rapidly causing a general septic peritonitis." Newell states that when a woman is frankly infected, no operation which conserves the uterus offers a good chance of preventing peritonitis since even in the extraperitoneal section the bacteria may find their way through the unopened peritoneum. For this reason he advises the removal of the uterus in that type of case. We have not done the transperitoneal operation on a frankly infected case; but in our hands this procedure has given definite protection in the presumably infected woman. Many obstetricians feel that the danger of infection does not come so much from the spilling of the uterine contents at the time of operation as from the passage of lochia and bacteria between the sutures after delivery.

At the present time we resort to the Hirst operation in our doubtful cases, and to the Kroenig or Beck operation in our clean cases.

THE CERVICAL INCISION

The cervical incision has a number of points in its favor. The cervix is that part of the uterus which stands infection the best—a fact repeatedly observed in gynecological practice. The pelvis is also more resistant than the upper abdomen; the wound is placed in the non-contactile part of the uterus and may heal undisturbed. The healing of the cervix is better than that of the fundus because active involution and the fatty degeneration of the uterine wall defeat the healing powers of the tissues (Munro Kerr).

This incision is well covered with peritoneum which is adherent in the course of a few hours, so that when bacteria invade the uterus, as they usually do on about the fifth or sixth day, if the uterine incision breaks down a local abscess forms which drains itself through the vagina, or through the lower angle of the abdominal incision, or it may be readily reached through an anterior vaginal colpotomy.

TABLE I.—TOTAL NUMBER OF OPERATIONS

	Hirst	Kroenig	Beck	Total
Cases operated upon by the author	39	23	5	67
Cases operated upon by Dr. J. G. Hegarty	10	3	..	13
Total	49	26	5	80

TABLE II.—NUMBER OE PREGNANCIES

	Hirst	Kroenig	Beck
Para-I	34	11	2
Para-II	8	8	1
Para-III	..	3	..
Para-IV	3	2	2
Para-V	1	1	..
Para-VI	1	..	..
Para-VII	1	1	..
Para-VIII	..	..	..
Para-IX	..	..	..
Para-X	1	..	..
Total	49	26	5
Total cases			80

TABLE III.—LABOR

	Hirst	Kroenig	Beck
Test of labor	33	10	2
No labor	16	16	3
Total	49	26	5
Total cases			80

Of the 33 Hirst operations who had labor, one had 36 hours, one 24 hours, and one 20 hours. The others had labor varying from 4 to 15 hours.

RUPTURE OF THE SCAR IN SUBSEQUENT PREGNANCIES

The incision in the lower uterine segment reduces to a great extent the possibility of rupture of the scar in subsequent pregnancies, because of the fact that the incision heals at rest and undisturbed. In our series there were six secondary operations, one in a woman who had had a septic uterine incision and a utero-abdominal fistula. In none of these cases were there any weak points in the scar and it was almost impossible to distinguish a scar as such. In his 12 cases which came to secondary operation Gaifami found no signs of weakening in any of the scars.

ADHESIONS

Following the Hirst operation, one finds a band of peritoneum extending from the abdominal wall to the cervix. Four of our cases came to secondary operation. We merely divided the peritoneal band between ligatures, separated the bladder and performed the Kroenig section. In the two Kroenig hysterotomies who came to operation the second time, no adhesions were found and there was not the least difficulty in separating the bladder for the second time. As the latter operation is completed, but a short line of suture is exposed, and that is where the peritoneum is attached to the uterine wall; this sinks in the pelvis and is entirely covered over by the bladder as this organ fills.

TEST OF LABOR

The patient may be given an efficient test of labor and this with safety. The result of this is that a number of cases are delivered through the pelvis who might have been delivered abdominally with the absence of this test. It is a well-conceded fact that an efficient test of labor adds materially to the morbidity and mortality of the classic operation. DeLee, Cornell, Routh, Holland, and Beck, all agree that an efficient test of labor is safe with the cervical section. Our own experience bears them out. In German clinics the low cervical operation is performed even if the parturient has fever (DeLee).

HERNIA IN THE ABDOMINAL INCISION

Hernia has not been encountered in our cases, even the women who developed utero-abdominal fistulæ obtained firm scars. It is a known fact that herniæ in suprapubic incisions are less common than in the other parts of the abdomen.

CONVALESCENCE

The convalescence in cases of the cervical section is practically that of a pelvic delivery. The puerperium is so comfortable following the low cervical operation that one cannot help but be impressed with this advantage. A rare case develops a moderate distention, but we have been impressed with the fact that, in our series, it has always been a soft distention, causing the puerpera no discomfort. The patients are free from ileus, the temperature and pulse remain near the normal line, and no signs of peritoneal shock are observed. If the operation accomplished

TABLE IV.—PELVIC EXAMINATIONS

	Hirst	Kroenig	Beck
Vaginal examinations	9	1	0
Rectal examinations	40	25	5
Total	49	26	5
Total cases			80

The largest number of vaginal examinations on one case was six.

TABLE V.—INDICATIONS

	Hirst	Kroenig	Beck
Cephalopelvic disproportion	30	11	1
Abruptio placentæ	3	..	..
Complete placenta prævia	6	1	..
Eclampsia; rigid primiparous cervix	2	3	..
Previous classical cæsarean section	4	3	1
High breech; contracted pelvis	3	1	..
Transverse; right scapuloposterior. Para. V. Four Stillborns	1	..	..
Previous Hirst operation	..	3	1
Large dermoid cyst obstructing labor	..	1	..
Soft part dystocia from previous plastic	..	..	..
Operations and suspensions	..	3	..
Diabetes. Toxæmia of pregnancy	..	..	1
Elderly primipara (40). Rigid cervix	..	..	1
Total	49	26	5
Total cases			80

nothing more than the comfortable convalescence, it would be worth while doing for this reason alone.

MORBIDITY

Hirst Operation—49 Cases

Seven puerpera had septic uteri and uteroabdominal fistulæ, discharging pus freely through the vagina and through the abdominal incision. All wounds were irrigated with Dakin's solution. All the patients recovered. None of the cases developed peritonitis. This group tends to prove that the union of the peritoneal layers in the Hirst operation offers a definite protection against peritonitis.

CASE 1. Para-I. Abruptio placentæ, packed twice, once in her home, attempts at manual dilatation before admission.

CASE 2. Para-I. Admitted after 36 hours of labor with a floating head and ruptured membranes. This case was one of extreme sepsis, the whole cervical incision broke down, and one could introduce the sterile fingers through the abdominal opening into the fundus as well as into the cervix. She ran a temperature ranging from 105 to 102, with a pulse of 150 to 130 for 20 days. On the twentieth day her hæmoglobin was 30 per cent and she was transfused on this day. She left the hospital on the fifty-second day with a healed incision and in good health. The impressive fact about this case was that while pus was pouring freely from the broken down cervical incision, there was not the least sign of peritoneal irritation, the bowels and bladder functioned normally, and she experienced no abdominal symptoms.

CASE 3. Para-I. Right occipitoposterior, floating head, long labor, vaginal examinations outside.

CASE 4. Para-I. Right occipitoposterior, floating head, few hours of labor, no engagement, intact membranes, no vaginal examinations. This might have been considered an ideal case for the classic operation.

CASE 5. Para-I. Short test of labor, breech left sacroposterior neurotic woman, no progress, intact membranes, no vaginal examinations. This case might also have been considered in an ideal condition for the classic operation.

CASE 6. Para-I. Elderly, in labor a number of hours before admission, no engagement, intact membranes, eczema of the vulva, no vaginal examinations.

CASE 7. Para-I. Admitted fully dilated, no engagement, membranes intact, no vaginal examinations.

These seven cases with septic, broken-down cervical incisions were prevented from having general septic peritonitis by the protection offered by the united peritoneal layers. They all recovered and were discharged with healed incisions. One of them, the first case, who was operated upon later by the Kroenig method showed a perfectly healed cervix. Another, Case 4, now 5 months pregnant, is in the writer's care, and her second pregnancy is progressing satisfactorily. Two of the cases fulfilled the indications for the classical operation, that is, just enough labor to dilate their cervices for drainage, intact membranes, never examined vaginally during pregnancy or labor, and yet, we are convinced that they would have died of peritonitis had the latter operation been performed. The last two cases may explain the occasional case of peritonitis, following the classic operation, when we feel that all indications have been fulfilled. Furthermore, it tends to prove that the infecting bacteria were present in their vaginæ, since they were never carried in by the examining fingers. The other five cases were considered potentially infected.

Six patients had mild uterine sepsis, with a temperature of 101 degrees, they had no abdominal complications and they all did well.

One patient had bilateral mammary abscesses, a second had bronchopneumonia, while a third had pyelitis.

Kroenig Operation—26 Cases

One patient had pulmonary embolism during the operation, which was followed by pneumonia and recovery: another had a pulmonary embolus the twelfth day after operation: she also recovered. Two puerperæ had thrombophlebitis of the left leg; they left the hospital well. One mother had acute dilatation of the stomach; she recovered.

Beck Operation—5 Cases

There were no complications.

MORTALITY

Hirst Operation

CASE 1. Para-VII, spondylolisthetic pelvis, six stillborn children following forceps extractions, admitted after considerable labor in her home, no vaginal examinations. She died of pulmonary embolism on the fifth day after delivery. There were no abdominal complications.

CASE 2. Para-I, 41 years old, in labor 16 hours. One vaginal examination in her home. Died of acute gastric dilatation on the fourth day. The parturient who was about 5 feet in height weighed 250 pounds, she had a sharp promontory, and no engagement after 16 hours of labor. She had had acute dilatation of the stomach following an appendectomy a few years previously and her history showed that she had nearly died of this complication.

CASE 3. Para-I. Abruptio placentæ at term with a severe uterine hæmorrhage. She had no dilatation and no labor. She died of the results of hæmorrhage the day of operation.

Kroenig Operation

CASE 1. Para-II, 28, first labor breech presentation, stillborn, poor physical condition, attack of appendicitis when 7½ months pregnant, and she ran a pulse of 120 during pregnancy. Extensive plastic operations following the first delivery. Test of labor, no dilatation of the cervix, operation August 23, 1922. She developed an abscess between the bladder and cervix, which was drained by an anterior vaginal colpotomy on September 3, 1922. She subsequently developed a bronchopneumonia and died. At the time of her death the abdominal incision was healed, and she had had no abdominal symptoms.

CASE 2. Para-I, 42 years old, at term, eclampsia, frequent convulsions, no labor, no dilatation, moribund when seen. Operation in the interest of the child. The mother died shortly after operation and the child lived.

CASE 3. Para-I, 36 years old, at term, eclampsia, frequent convulsions, in deep coma, cyanosed and jaundiced, no labor, two vaginal examinations, 1 ounce of black urine obtained on catheterization, delivered of a macerated fetus. No urine was obtained after operation and she died 14 hours after delivery.

Beck Operation

There was no mortality following this operation.

Total mortality 6 cases in 80, or 7.5 per cent. The mortality in this series cannot be entirely attributed to the operation. One mother died of pulmonary embolism on the fifth day, and while this is a complication of cæsarean section, it also occurs as frequently after pelvic deliveries. The two cases of eclampsia, in the writer's opinion, died because of lack of prenatal care; they were both elderly primiparæ and when seen in consultation it was too late to hope to save them. The parturient with the premature detachment of the placenta had to be delivered at once because of the hæmorrhage, she was at term, she had a long rigid cervix, and no labor. After the delivery of the fetus, the extraction of the placenta and membranes, and the removal of a large quantity of blood clot, the patient went into severe shock. She rallied after the intravenous injection of 1000 cubic centimeters of salt solution, but a few hours later began to fail, and died just as the writer was reaching the hospital to transfuse her. This leaves two patients (2.5 per cent), one who died of bronchopneumonia, after having had an abscess drained and, as stated before, without having had any abdominal complications. The pneumonia may have been secondary to the abscess or it may have been the result of the patient's markedly weakened condition. Acute gastric dilatation is not usually seen after pelvic deliveries, so in this case the operation may be said to have been the cause of death, and yet, one of the patients in the series of Kroenig operations recovered from this same complication.

TABLE VI.—ANÆSTHESIA

	Hirst	Kroenig	Beck
Ether anæsthesia	49	24	5
Spinal anæsthesia	..	2	..
Total	49	26	5
Total cases			80

Spinal anæsthesia was administered to two women who had severe upper respiratory tract infections. The operation is well adapted to spinal anæsthesia, the only variation in technique being that the patient is not placed in the Trendelenburg position. The extensive dissection of the peritoneum would make the operation difficult to do under local anæsthesia.

SECONDARY OPERATIONS

Four gravidæ had Kroenig operations after having had the Hirst operation; one had a Beck operation after the Hirst operation; while another had two Kroenig operations; thus making a total of six secondary operations. In none of these were we able to identify a scar, as such, in the cervix, and there was no difficulty in separating the bladder a second time. It is interesting to note that the first case who came to a secondary operation was the first done in the Hirst series—this was a septic case with a utero-abdominal fistula—and yet, at the second operation the incision was found perfectly healed and no weak points were discovered. As far as the cicatrix was concerned the parturient might have had a pelvic delivery with safety had it not been for the fact that she had an absolute indication.

TABLE VII.—FETAL MORTALITY

Five children died, four after the Hirst operation and one after the Kroenig operation, or a mortality of 6.25 per cent. The causes of death were the following:

Macerated fetus	2
Stillborn	1
Atalectasis	2
Total	5

CONCLUSIONS

1. The transperitoneal cæsarean section offers protection against septic peritonitis;
2. There is practically no shock as the intestines are not handled;
3. There is less bleeding;
4. The mother has a much easier puerperium;
5. There is better healing since the incision is in the cervix, the non-contractile part of the uterus;
6. There is less danger of rupture in subsequent pregnancies and labor;
7. An efficient test of labor may be given with safety;
8. We prefer the Hirst operation in doubtful cases, and the Kroenig or Beck operations in clean cases.

BIBLIOGRAPHY

1. Beck, Alfred C. The two-flap low incision cæsarean section. Surg., Gynec. & Obst., 1921, xxxiii, 290–296.
2. Cornell, E. L. The cervical or Kroenig cæsarean section. Illinois M. J., 1920, September.
3. DeLee, Joseph B. The newer methods of cæsarean section. J. Am. M. Ass., 1919, lxxiii, 91–95.
4. DeLee, Joseph B., and Cornell, E. L. Low cervical cæsarean section (laparotrachelotomy); results in one hundred and forty-five cases. J. Am. M. Ass., 1922, lxxii, 109–115.
5. DeLee, Joseph B. Practical Medicine Series, 1922, pp, 341–364.
6. Frank. Ueber den subkutanen Symphysenschnitt. Monatschr. f. Geburtsh. u. Gynaek., 1910, xxxii, 680.
7. Gaifami, P. Rev. franç. de gynéc. et d'obst., Paris, 1923, xviii, 33.
8. Hirst, Barton Cooke. Atlas of Operative Gynecology. 1919, 234–246.
9. Kroenig. Transperitonealer cervicaler Kaiserschnitt. In Kroenig-Doederlein's op. Gynaek., 1912, p. 879.
10. Kuestner, O. Der abdominale Kaiserschnitt. Wiesbaden: 1915.
11. Kerr, Munro. The lower uterine segment in conservative cæsarean section. J. Obst. & Gynæc., Brit. Emp., 1922, xxviii, 475.
12. Markoe, J. W., and McPherson, Ross. Extraperitoneal cæsarean section in certain infected cases with the Carrel after-treatment. Surg., Gynec. & Obst., 1918, xxvii, 2, 209–219.
13. Newell, Franklin S. Gynecological and Obstetrical Monographs. Appleton, 1921.
14. Polak, John Osborne, and Beck, A. C. The present status of operative obstetrics referring to the abuse of cæsarean section. Surg., Gynec. & Obst., 1922, xxxiv, 566–574.
15. Phaneuf, Louis E., and Hegarty, Joseph G. The transperitoneal cervical cæsarean section. Boston M. & S. J., 1922, clxxxvi, 733–738.
16. Thomas, T. G. Gastro-elytrotomy; a substitute for the cæsarean section. Am. J. Obst., 1871, iii, 125.

THE TREATMENT OF CARDIOPATHS IN PREGNANCY AND LABOR[1]

By W. C. DANFORTH, B.S., M.D., F.A.C.S., Evanston, Illinois

THE prognosis of pregnancy in women in whom cardiac lesions exist is often very difficult. The experienced observer may often be in doubt as to the degree of danger to be feared and as to the proper course to pursue. Women whose hearts are seriously compromised, even in whom decompensation is found, will sometimes pass through pregnancy and labor, particularly if judiciously managed, with comparative ease. Others, whose hearts apparently give but little reason for anxiety, indeed sometimes when careful examination discloses no abnormality, may be overtaken by serious trouble and at times by disaster. The problem of estimating the degree of risk, and of determining the safest course to pursue often perplexes us.

We have had a number of cardiopaths to deal with on the gynecologic-obstetric service of the Evanston Hospital in recent years. Of these, the most striking example of the class of cases alluded to above, in which examination discloses no deviation from normal, yet disaster follows, is here reported.

Case 1. Primipara, age 28. Physical examination during pregnancy had shown no physical abnormality and repeated observation of blood pressure and examination of the urine during pregnancy showed nothing noteworthy. Labor came on at term. The child lay in left occipito-anterior, there was no disproportion, and labor proceeded in an entirely normal manner. After 5 hours, the os was dilated three fingers' breadth, and at this time the heart was auscultated and found normal, and the pulse was not above the normal rate. After 8 hours of apparently normal labor the head was on the perineum, the parturient seemingly in excellent condition. After a delay of 45 minutes on the perineum, it was decided to complete the delivery by forceps. The woman was placed in position and anæsthesia begun, using Squibbs' ether on an open mask. After 4 or 5, minutes the interne began to sponge off the external urethral meatus, preparatory to catheterization. She moved her limbs vigorously at which he ceased, to await completion of anæsthesia. Not more than 1 minute later the anæsthetist reported that the woman was not breathing. At first this caused no alarm, attempts being made to cause her to breathe by pulling the jaw forward. After a moment it became apparent that the condition was alarming, and attempts were made by every means with which we were acquainted to cause her to breathe, but without avail. No further respiration occurred and in about 7 or 8 minutes the heart ceased. Prior to the stopping of the heart the child was rapidly extracted with forceps. It, however, succumbed a few hours later.

An autopsy was made by the coroner's physician, who fortunately was an experienced pathologist. The entire reproductive tract was found wholly normal, no injury to the uterus being present and the placenta being firmly attached to the uterine wall. No emboli could be found in the vessels of the lungs and none was present in the heart. There was a chronic adhesive pericarditis, the pericardium being firmly attached to the heart over its entire surface. The heart muscle seemed paler than normal and a provisional opinion of death from myocarditis was given. Microscopic examination of the heart muscle made later did not show evidence of degeneration.

This death must, it would seem, be ascribed to anæsthesia, the disastrous effect of the anæsthesia, perhaps, being the more easily produced by reason of the handicapping of the heart muscle by the old pericarditis. We cannot too strongly urge the importance of the pericarditis in determining the cause of the death, as the heart continued to beat for some minutes after respiration had stopped.

It is probable that this death must be ascribed to anæsthesia, inasmuch as autopsy failed to disclose a sufficient explanation.

There can be no death more distressing than that of a young and apparently healthy woman in labor. Happily the physician is not frequently called upon to experience the sense of helplessness and defeat which are his when witnessing such a catastrophe. But that such deaths are by no means unknown is demonstrated by an examination of the literature. In 1905 Davis reported a case of death during the termination of pregnancy and collected twenty-five other published cases.

An examination of the literature since the publication of Davis' paper discloses 54 cases of death during the termination of pregnancy or immediately thereafter. We have excluded

[1] Read before the Chicago Gynecological Society, April 20, 1923. (For discussion see p. 852.)

all deaths from this list from obstetric accidents such as hæmorrhage, rupture of the uterus and eclampsia, and have included only those due to circulatory causes. Of these we have included only those in which death occurred during the process of parturition or immediately thereafter, excluding those in which many hours had elapsed before death. The following table shows the reported causes of death.

Cardiac lesions		29
Mitral stenosis	15	
Myocarditis	7	
Bicuspid lesions	4	
Pericarditis	1	
Endocarditis	2	
		29
Embolism		8
Air embolism		2
Cerebral hæmorrhage		2
Pulmonary tuberculosis		1
Cause in doubt		12
		54

In endeavoring to arrive at an estimate of risk in a given case it is evident that the type of cardiac lesion must be considered. Mitral stenosis has claimed more victims than any other cardiac lesion in the cases as reported. Myocarditis occupies second place. Our own experience is in accord with this. It is of interest that lesions of the mitral valve do not appear in the list at all, unless one or both of the two cases indefinitely reported as "endocarditis" be of this type.

It would seem that aortic regurgitation should be even more serious in its consequence than mitral stenosis. Pardee finds in his experience that it is about twice as likely to cause trouble. They occur only half as frequently as mitral stenosis, which he feels is the reason for the latter lesion being more greatly feared. We have perhaps been fortunate so far in not encountering one.

The heart of the pregnant woman demands careful study, which should be begun as early as possible in the pregnancy. A carefully taken history is essential, eliciting such facts as the occurrence of rheumatic fever, repeated tonsillitis, chorea, scarlet fever, diphtheria, or other infections likely to leave cardiac damage behind them. Careful routine physical examination of the heart should be made, including observation of blood pressure, systolic and diastolic, in order that the pulse pressure may be known. The presence of a murmur is by no means always an occasion for alarm, nor does its absence invariably confer a sense of complete safety. The most important question is whether the heart is fulfilling its function without effort. In our own work we are accustomed to pay particular attention to previous history of endocarditis. The presence of demonstrable cardiac enlargement, and any sign of decompensation, such as dyspnœa on effort, slight œdema of the ankles, especially when crepitant sounds are found at the bases of the lungs, is regarded as evidence of possible danger. A pulse pressure of less than 30 indicates a heart muscle of diminished efficiency, and a systolic pressure persistently 100 or less is a cause for anxiety. Evident decompensation in early pregnancy is a valid reason for emptying the uterus. In cases giving definite evidence of impairment of cardiac efficiency, we should have the co-operation of the internist.

We are most concerned when we are dealing with mitral stenosis and myocardial degeneration. These are, according to the table given and also according to our own experience, the most dangerous lesions. The difficulty as to prognosis in these cases may be illustrated by the following cases.

CASE 2. II-para, age 26, seen in consultation during her first pregnancy on account of paroxysmal tachycardia. She went through this pregnancy and was safely delivered in another city. In her second pregnancy she was under the writer's care. She had a mitral stenosis and regurgitation, a presystolic murmur being easily heard. She had a number of attacks of paroxysmal tachycardia. She was seen by an internist, and the question of the advisability of terminating pregnancy was considered. It was decided not to do this and the pregnancy proceeded under careful observation. She went through labor without the slightest difficulty. As the second stage was evidently going to be rapid and she was in excellent condition she was allowed to deliver herself.

CASE 3. I-para, age 22. Apparently in vigorous health. Had recently completed her training as a nurse in a large hospital. While thus actively employed she had had no evidence of any trouble with her heart. Three years before she had had a severe attack of epidemic influenza. During her entire pregnancy her heart gave no sign of any abnormality. Immediately on the onset of labor she had an acute dilatation of the heart, a rapid irregular pulse with beats of varying strength, some not palpable at the

wrist, dyspnœa, and cyanosis. She was at once given large doses of morphine to delay the labor, and following the advice of a medical consultant heavy doses of digifolin intramuscularly. Pains ceased for nearly 24 hours, then recommenced. By this time the pulse was again regular and the dyspnœa greatly lessened. She was allowed to proceed with administration of morphine until dilatation was complete. As the child was right occipitoposterior, a manual rotation was done, followed by forceps extraction. She stood the entire labor and operative procedure well.

In the one case the fears occasioned by the presence of physical signs and evidence of functional impairment were not realized. In the other evidently a myocardial change was present which was not shown by careful examination in pregnancy but which became apparent immediately upon the imposition of the extra strain of labor.

Sir James Mackenzie divides heart force into two forms: rest force, which is sufficient for the needs of the body when at rest, and reserve force, which is used only when an effort is made. The reserve force is drawn upon in pregnancy. The maintenance of the fetal circulation, the carrying of extra weight by the mother, and the embarrassment of the heart itself which follows the alteration in movement and shape of the chest, all make demands upon it. And labor makes a still greater demand, a demand which may entirely obliterate the narrow margin of reserve remaining after the demands of pregnancy have been met.

If we could accurately measure the reserve force we should be far better able than we are at present to estimate the danger in a given case.

The woman with a heart which in early pregnancy is definitely decompensated need not perplex us. The course to pursue in such a case is perfectly obvious. Should the case be one in which one cannot expect the ultimate recovery of the heart to a point at which pregnancy and labor may be regarded as safe, the advisability of emptying the uterus from above by hysterotomy and sterilization by excision of the cornual ends of the tubes may be considered. Should a general anæsthetic be considered dangerous it may be done under local anæsthesia and morphine-scopolamine. A combination of these and a properly given gas anæsthesia or analgesia works very well. In a limited experience we have found this combination to be a useful method in severely compromised cases.

In those cases in which immediate termination of pregnancy is not indicated, and these cases are by far the more numerous, one faces the task of constant careful observation during pregnancy and the choice of the safest means of accomplishing delivery at term.

In the rather frequent cases of regurgitant mitral lesions which are well compensated, as evidenced primarily by the fact that the circulatory function is well maintained, and only secondarily by consideration of the murmur which may be present, we ordinarily feel but little anxiety, as experience has shown that these cases nearly always pass through pregnancy and labor well, frequently sustaining the strain of a protracted labor without incident.

Mitral stenosis is a more serious matter. Where this lesion is present careful attention must be paid to the heart throughout pregnancy, the woman cautioned regarding strain. Those of us who are caring for patients in large cities must be careful in regard to that numerous class of patients who live on the second or third floors of apartment buildings which contain no elevators.

Complete bed rest and administration of heart stimulants should begin on the slightest evidence of lack of compensation, preferably with the collaboration of an internist. The appearance of auricular fibrillation necessitates complete rest and reduction of pulse rate by digitalis. Should any evidence of pulmonary œdema or hepatic enlargement appear, termination of pregnancy must be considered.

The termination of pregnancy requires decision as to the best way of emptying the uterus. Our experience has led us to prefer, with a very occasional exception, delivery by the normal route. It has seemed to me that those who make frequent use of abdominal section in cases complicated by heart lesions are attracted by the fact that delivery may be rapidly accomplished, but fail to appreciate the fact that a woman who has had an abdominal section has still a postoperative period to pass through, which, in the case of

cæsarean section, is not always as free from strain as we might wish. Our observation in a considerable number of sections has been that distention and vomiting occur, even in cases in apparently excellent condition prior to operation, and despite the fact that the operation may have consumed but a very brief time, to a considerably greater degree than in gynecological laparotomies which may be much more difficult and time consuming. This throws a considerable measure of strain upon a compromised heart and may easily prove to be too great a load for the heart which has passed through the operation well. We prefer as a rule, therefore, to allow our patients to pass through the first stage, lessening their discomfort by the use of morphine, with which we are inclined to be rather liberal, giving often considerably more than we would give in a similar case with no heart to consider.

In multiparæ at the end of the first stage, the second stage, including delivery, is allowed to proceed normally with the addition of gas analgesia, provided the second stage is evidently going to be short and accompanied by little strain, and provided the patient's heart has shown no sign of failing.

In primiparæ, and in those multiparæ in whom we fear the strain of the expulsive stage, the labor is operatively terminated at this point, with a minimum of trauma. Morphine is often again given at once after labor to promote rest and to quiet the heart.

This conservative course has, we believe, yielded us as good results as we could hope to attain. Fortunately the cardiopath tends to have a rather easy first stage, and, particularly in multiparæ, the entire labor is often far less taxing than the anxious attendant had dared hope.

Difference of opinion, of course, exists as to the best and safest way to end the pregnancy. Induction of labor and cæsarean section both are suggested and recommended by various writers. The labor which comes on spontaneously has in our experience been a more rapid and more satisfactory one than the induced labor, and this fact has caused us to reject induction as a rule. The fact that labor not infrequently ceases after expulsion of the bag is a disadvantage as the woman and her compromised heart are subjected to a strain which is unproductive, and must be undergone again.

In our experience, too, it has seemed quite clear that after cæsarean section the strain of vomiting and that which is incident to abdominal distention and measures directed toward its relief, when added to that due to the operation, make up a sum total greater than that which many of our patients have had in accomplishing delivery by the natural passages. The latter has the great advantage of permitting the woman to have complete rest immediately after labor. We would, therefore, reserve section for cases which seem to promise unusual difficulty in labor.

We have not discussed the use of the electrocardiograph. In our own work it has not been used, and we have therefore no basis of personal experience. The gynecologist or obstetrician is not competent to evaluate this modern refinement of diagnosis. It would seem, however, that at least in the great majority of cases of cardiac lesions in pregnancy a sufficiently comprehensive idea may be attained by careful examination and observation, particularly if the collaboration of the internist be sought.

The great majority of men who are forced to accept the responsiblity of management in cases such as those we are discussing are without access to such apparatus. Trained faculties and painstaking observation, in the opinion of internists of wide experience, seem still to be the most valuable means of determining diagnosis and treatment.

The necessity for a cultivated operative dexterity and the employment of a minimum amount of trauma is so obvious as to require no emphasis.

The question of anæsthesia is one of primary importance. The importance of the anæsthetist as a member of the surgical team has received increasing recognition of late years. A woman with a decompensated heart, who needs operative intervention, may well tax the skill of the most experienced anæsthetist. The operator who must work in an institution in which anybody gives the anæsthetic will, in spite of his best efforts, have an occasional bad result in these cases which might possibly have been avoided with better anæsthesia.

While we have for some time used nitrous oxide for nearly all obstetric surgery except version or manual rotation of the head, both of which require a little more relaxation than is easily obtainable with gas, we believe that carefully given drop ether is preferable for operative work in cardiac cases except when fully compensated. The ether has some value as a heart stimulant, and causes less rise of blood pressure. I wish in this connection to record my appreciation of the complete and whole-hearted co-operation which I have received from the anæsthetists of the Evanston Hospital in meeting many difficult situations.

For ideal results one must have the assistance of anæsthetists of proper general training together with some especial experience in obstetric anæsthesia.

SUMMARY

1. The functional capacity of the pregnant woman's heart should be considered as early in pregnancy as possible. The aid of the internist in this and other things is of the greatest value.

2. Immediate attention must be given to any evidence of overstrain of the heart.

3. Of the lesions commonly seen, mitral stenosis and myocarditis are by far the most to be dreaded.

4. Delivery by the natural passages is ordinarily preferable, aided by morphine in the first stage and operative delivery if needed in the second stage.

5. Cæsarean section is, as a rule, not the best treatment for women with decompensated hearts.

SACRAL TERATOMA

By GEORGE DAVID CUTLER, M.D., F.A.C.S., Boston
From the Surgical Service, Children's Hospital

THE following report of a case of congenital sacral teratoma with operation 15 hours after birth is considered sufficiently interesting and unusual to warrant reporting.

J. M. (C. H. No. 50261), an Italian infant 15 hours old, was referred to the Children's Hospital by Dr. D. J. Herlihy of Cambridge, Massachusetts, June 24, 1922, for examination and treatment of an unusual tumor over the sacrum. The family history was negative. Physical examination showed a well-developed and nourished infant with entirely negative physical examination except for local condition. Local examination over the sacrum and upper part of the gluteal region showed a fairly solid, irregular, rounded tumor, 3 by 4 inches in size, with soft cystic tissues protruding from an opening in a tube of skin covered with hair. The pre-operative diagnosis was sacral teratoma.

Operation. Ether. Excision of teratoma. Two curved incisions were made around the base of the tumor over the sacrum, with the long axis in the transverse direction, the skin flaps were dissected away from the mass, which was found to contain a good sized piece of bone which seemed to articulate with the sacrum. The mass was dissected free with scissors. During the dissection a small sized cyst containing gelatinous material was opened. The sacrum felt normal in size and shape and position. Two good sized vessels of supply entered the mass on either side. These were clamped, cut, and tied with chromic catgut. The wound was closed with buried stitches of plain catgut to the subcutaneous fascia and interrupted stitches of silk to approximate the skin edges, making a satisfactory reconstruction of the buttocks. The patient made an uneventful recovery from operation and has been followed up for over 6 months. Development has been normal.

I am indebted to Dr. S. B. Wolbach for the following pathological report:

"The tumor contains a number of different tissues grouped together without order or sequence. There is bone in juxtaposition to nervous tissue, and nerve tissue in contact with epithelium-lined spaces equipped with glands, suggesting the mucosa and adnexa of bronchi. There are also islands of cartilage fat, and acini resembling the acini of the breast. In connection with the nerve tissue there are plexuses of vessels with and without a covering of epithelium resembling choroid plexus. Where the bone is cancellous there is marrow in which there are blood-forming cells. There are large masses composed apparently of ganglion cells and nerve fibrils. There are normal arteries and veins of large size. Medullated nerve fibers are present. In blocks examined the different tissues suggest an organoid development; no cells were found having the arrangement usually seen in tumors."

I have been unable to find a similar case among the records at the Children's Hospital, Boston. The condition is described in Keen's *Surgery* (1) where the following definition appears: "A teratoma is an irregular conglomerate mass containing the tissues and fragments of viscera belonging to a suppressed fetus attached to an otherwise normal individual." Two forms are named: external and internal. The case herewith reported represents the external type of teratoma.

Without going further into a consideration of teratology, when two embryos are conjoined and one goes on to complete development while only certain parts of its companion continue to grow, the result is a parasitic

Fig. 1. Posterior view of infant and teratoma. Note the tube of skin covered with hair with mass of tissues protruding through an aperture.

Fig. 2. Left lateral view showing relation of parasite to autosite.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 3. Relation of the mass to the anus. Note the protruding mass of soft tissues definitely to the right of the median line. Discoloration of perineum, vulva, and buttocks due to meconium and a little blood.

Fig. 4. Five days after operation.

Fig. 5. Showing operative wound. Lateral view, 5 days after operation.

Fig. 6. Roentgenogram taken after operation to demonstrate condition of the sacrum.

Fig. 7. Roentgenogram of specimen taken to show the configuration of the bony structures.

fetus. The mature individual supporting it is called the autosite. The case reported above is one in which the suppressed fetus is represented by the mass growing from the posterior surface of the sacrum. For a more complete description of the condition, the reader is referred to textbooks on pathology (2) and embryology (3).

In the recent literature, Bolognesi (4) has written on cystic teratomata, stating that the site of predilection is the sacrococcygeal region. He reports a case in a twenty day old infant from whom the tumor was removed with satisfactory result. He comments on the fact that these tumors are monstrosities rather than neoplasms. Montgomery (5) published an article last year on this subject

and reported a case of sacral teratoma containing a scapula. He gives the differential diagnosis of tumors in the sacral region naming ordinary lipomata, lymphangiomata and congenital sacrococcygeal tumors, which have been classified by Ewing into dermoids, simple or complex; teratoid tumors; teratomata; and fetal implantations. He considers the roentgen-ray examination of considerable assistance in the diagnosis of these teratomata, and remarks that because of the operative dangers, a neurological examination should be made to differentiate a teratoma from a meningocele, especially when the latter accompanies and forms a part of a teratomatous growth.

REFERENCES

1. KEEN'S SURGERY. Philadelphia and London: W. B. Saunders Co., 1912, p. 818.
2. DELAFIELD and PRUDDEN. Textbook of Pathology. 10th ed. New York: William Wood, 1914, pp. 328, 358.
3. BAILEY and MILLER. Textbook of Embryology. 10th ed. New York: William Wood, 1911, p. 613.
4. BOLOGNESI, G. Néoplasmes, Paris. Abstracted J. Am. M. Ass., 1922, lxxix, 1803.
5. MONTGOMERY, A. H. J. Am. M. Ass., 1922, February 11. Abstracted Practical Med. Series, 1922, iv, 212.

ENTEROCYST

WITH REPORT OF A CASE

BY J. E. STRODE, M.D., AND E. A. FENNEL, M.D., HONOLULU, HAWAII
The Clinic

THE patient was a male infant, delivered by breech presentation after a normal gestation. He was the ninth child, all brothers and sisters living and well and without apparent congenital abnormalities. His weight at birth was 7¾ pounds.

During delivery and until time of operation a considerable quantity of meconium was passed; nothing else. The baby was delivered at 10 a.m. and was put to the breast during the afternoon and night and was given water several times. On the morning of the second day, vomiting began, at first of undigested fluids, and later of meconium. Gastric lavage was used without relief. Distention was first noticed the morning of the third day and was not relieved by enemata or stupes applied to the abdomen.

Visible peristalsis was at no time seen nor was a mass palpable. Shifting dullness was not elicited. Urine was voided normally and catheterization of the bladder showed no retention. The pulse and temperature remained practically normal. The child at no time seemed to be in pain.

On the morning of the fourth day operation was decided upon as the symptoms had become more pronounced. A diagnosis of intestinal obstruction, with intussusception or a congenital abnormality for cause, was made.

A right rectus incision was made below the umbilicus. Considerable cloudy fluid escaped on opening the peritoneum. All of the small intestines were greatly distended and deeply injected. Exploration in the cæcal region revealed a round, cystic tumor, about 1.5 centimeters by 1 centimeter, protruding from the anterior surface of the ileum, about 6 centimeters proximal to the ileocæcal junction. The gut distal to the cyst was collapsed and distended above. This cyst was quickly shelled out. It was then noticed that what was at first thought to be the lower portion of the distended gut was another cyst of about the same diameter as that of the distended gut above. The entire cyst-bearing area was then resected and an end-to-end anastomosis performed. Intestinal contents passed through the anastamosis after its completion. No other abnormalities were noted at operation, either in the intestine or the parietal peritoneum. The patient left the table in fair condition, but died about 5 hours later. No autopsy was secured. The pathological report on specimens removed at operation follows.

The tissue submitted for examination was a short segment of small intestine (ileum) some 5 centi-

Fig. 1. Drawing from photograph of enteric cyst, with enveloping section of ileum.

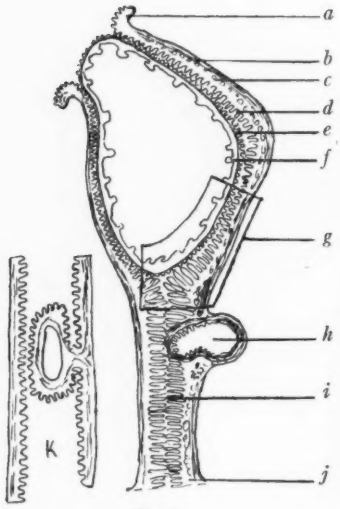


Fig. 2.

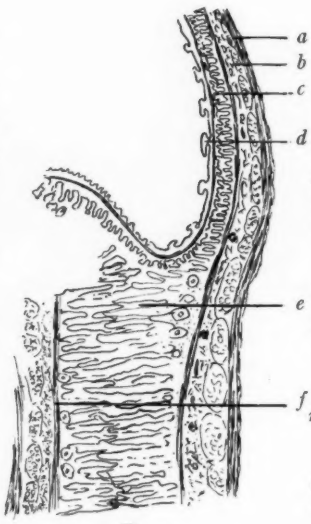


Fig. 3.

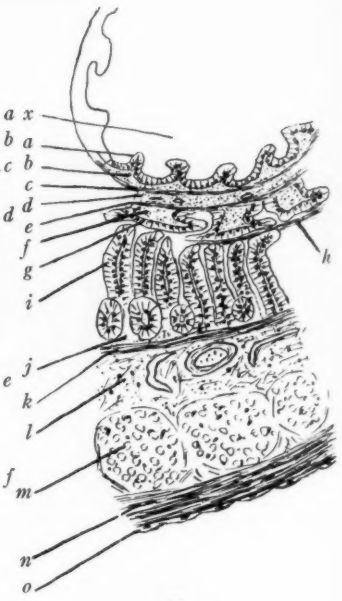


Fig. 4.

Fig. 2. Diagram of tissue removed at operation; a longitudinal section through intestine and two cysts. *a*, Oral end of specimen; *b*, longitudinal muscle of intestine; *c*, circular muscle of intestine; *d*, mucosa (villi) of intestine; *e*, epithelial villi, resting on muscularis mucosæ and *covering* cyst wall; *f*, columnar epithelium, in papillary folds resting on muscularis mucosæ and *lining* cyst cavity; *g*, area sectioned and illustrated in Figure 3; *h*, smaller cyst, enucleated at first stage of operation. Lined by papillomatous and flattened squamous epithelium and having a muscular wall continuous with the musculature of the intestine, but, unlike larger cyst, having no epithelial cover; *i*, opposite walls of intestine, in contact with each other, the villi intimately interwoven; *j*, anal end of specimen; *k*, diagram of probable origin.

Fig. 3. Semidiagramatic representation of section indicated in Figure 2. *a*, Musculature of intestine; *b*, submucosa of intestine, highly vascular; *c*, villi of intestine, in contact with flattened villi of cyst wall covering; *d*, low papillary folds of epithelium, lining cyst cavity, *e*, opposite walls of intestine in contact, gut lumen quite indistinguishable; *f*, muscularis of opposite intestinal wall.

Fig. 4. Sketch of cyst wall and intestinal wall. *a*, Low columnar epithelium, in papillomatous folds, lining cyst cavity; *b*, tunica propria of cyst lining; *c*, muscularis mucosæ of cyst lining; *d*, submucosa of both cyst lining and cyst covering, fairly vascular; *e*, muscularis mucosæ of cyst covering; *f*, tunica propria of cyst covering, *g*, columnar and cylindrical epithelium (also goblet cells) of the flattened villi of cyst covering, in most places in direct contact with the villi of the intestinal wall, although in places it is separated by a loose fibrinous deposit as indicated at *h*; *i*, epithelium of villi of intestine; *j*, tunica propria of intestine; *k*, muscularis mucosæ of intestine; *l*, highly vascular submucosa of intestine; *m*, circular muscle of intestine; *n*, longitudinal muscle of intestine; *o*, peritoneal covering; *x*, cyst contents, glairy, mucinous, colorless.

meters long, the lumen of which was completely occluded by a cyst which dilated the intestine to a diameter of about 3 centimeters. Below the large cyst (i.e., toward the anal end) in the intestinal wall, opposite the mesenteric attachment, appeared a small surgical wound, obliterated by a catgut suture. The small cyst removed from this site was submitted as a separate specimen.

These two cysts, particularly the larger one in the lumen of the gut, represent a rather unusual and highly interesting type of teratoma, the so-called enteric cyst.

Quoting the German literature (1) exclusively, Ewing (2) says, of these tumors: "Enteric cysts constitute a rather well-defined group of intraperitoneal cysts. They form single or multiple, large or small cysts, lying usually along the lower end of the ileum, in the wall of the intestine, at the point of Meckel's diverticulum (Roth) in the mesentery, or near the navel (Wyss). When originating within the muscular wall of the intestine they usually remain connected with this organ and are enclosed by a muscular wall. Arising in the subserosa, they remain attached to the convex side or project into

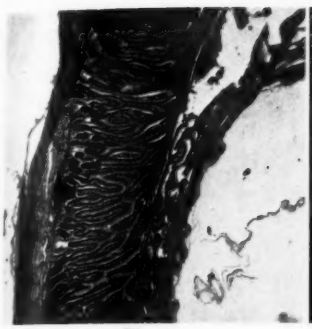


Fig. 5.

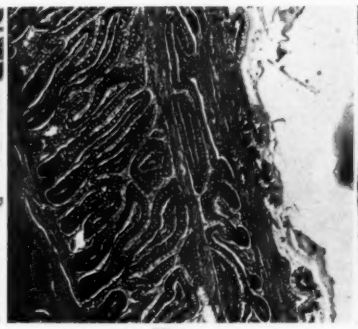


Fig. 6.

Fig. 7.

Fig. 5. Photomicrograph of intestinal wall and cyst wall, at point of mechanical separation.

Fig. 6. Photomicrograph of intestinal and cyst wall with villi of intestine and cyst covering in direct contact.

Fig. 7. Photomicrograph of intestinal and cyst wall, with a fibrinous deposit between the villi of the intestine and the villi of the cyst covering.

the mesentery. There may be definite malformation of the intestine. The cavity is usually single and the contents are mucinous, colorless, yellowish, or brownish. The wall resembles that of the intestine, and may contain smooth muscle, mucosa, crypts, lymphoid tissue, and a lining of cylindrical, or cuboidal or stratified epithelium (Colmers). The epithelium may show papillary proliferation. . . . There are probably several modes of origin of enteric cysts. Many originate from Meckel's diverticulum and are located at the lower ileum where they may communicate with the bowel (Ruge, Roth). At the navel they may be referred to the omphalomesenteric duct (Wyss). The term "enterodermoid" has been employed by Beneke to designate enteric cysts which arise from definitely misplaced portions of intestine."

Ziegler (3) says: "The cysts arise, in the peritoneal cavity, in part from snared portions of the intestine (enterocyst), in part from portions of the urachus (urachus-cysts). . . . The origin of the cysts lined with cylindrical epithelium can usually be determined only from their position and the character of their walls, but in the majority of the cases the origin can usually be ascertained beyond doubt. The diagnosis can be made with greatest certainty when the misplacement of the separated portion is slight and when the formation still shows clearly the character of the mother-tissue." Referring to secondary changes in these cysts, he says: "From separated portions of the intestinal mucous membrane it is probable that cylindrical celled carcinomata may take their origin."

In the main, this particular specimen is in accord with the above descriptions. The two tumors appear in the wall and in the lumen of the small intestine, at its lower end, though no tumors were found either in the mesentery nor in the intestinal wall at the normal location of Meckel's diverticulum. Nor were any tumors found near the navel. The malformation of the intestine was simply that due to complete obstruction—dilatation of the ileum above the large cyst and utter collapse below the cyst (a collapse so complete probably from the inception of the formation of the intestine, that the lumen of that portion of the gut was almost wholly obliterated, the villi of the opposing walls of the gut being intimately interlaced).

The contents of the larger cyst was a glairy, mucinous, quite tenacious, colorless semiliquid which contained some rather large embryonal type of cells with very small, deeply staining, centrally placed nuclei. The contents of the smaller cyst were lost at operation.

The component tissues of the walls of these two cysts differed rather decidedly. The wall of the small cyst was composed of smooth muscle, in bands that seemed to have no

particular order or arrangement, but being, after a fashion, as nearly as could be determined postoperatively, a continuation of the musculature of the intestine at this point. The lining consisted of a muscularis mucosa on which was mounted a single layer of cuboidal epithelium, shading, however, into flattened squamous epithelium at that portion of the cyst which bulged through the serosa of the gut, and to a papillomatous arrangement of cylindrical cells at that portion of the cyst which projected toward the lumen of the gut. Adherent to the lining epithelium were strands of mucinous material enmeshing many of those large embryonal type of cells, previously mentioned. (Incidentally, these cells were rather uncommon in the larger cyst.)- Below the lining epithelium was a sparse, but highly vascular submucosa. Epithelial cell rests within the wall of the gut, with secondary muscular hyperplasia seems the only hypothesis to explain the origin of this cyst.

The larger cyst—the one which wholly occluded the gut and which gave rise to the fatal symptoms of intestinal obstruction—presented an even more interesting structure on detailed examination. This larger cyst, about the size of a pigeon egg, was roughly ovoid in shape, filled with mucinous material, and presented in the tissues of its wall practically all the tissues of the small intestine, in orderly arrangement, with the addition of strange tissue. From the interior, outward it was shown to be made up of—

1. The lining of squamous, cuboidal but chiefly cylindrical epithelium, in single layer, but thrown up into low papillomatous folds;
2. A tunica propria;
3. A definite muscularis mucosa;
4. A quite vascular submucosa, that might be considered the submucosa of both the lining and the covering of the cyst;
5. A submucosa of the covering, with lymphoid tissue;
6. A tunica propria of the covering;
7. The epithelium of the covering. This consisted of cylindrical cells on a basement membrane arranged in the form of true villi, producing deep crypts. These villi were somewhat flattened, being in contact with the villi of the intestine, and rather broad at their bases. They contained numerous goblet cells. In other words, this layer was a slight modification of normal intestinal mucosa. These villi were in close contact with the villi of the intestine in most places, though in others a deposition of fibrous tissue had been laid down separating the epithelium of the cyst wall from the epithelium of the gut wall.
8. Continuing outward, the tissues of the gut were found to consist of normal tissues, normally arranged—epithelial villi, tunica propria, muscularis mucosa, a very vascular submucosa, circular and longitudinal muscle fibers and endothelium. The plicæ circulares seemed somewhat redundant.

The intestine below the site of the obstruction (the cyst had probably functioned as an obstruction since very early embryonal life) presented the unusual appearance of having the villi of opposing walls of the gut intimately interwoven, so that it was practically impossible to discover what would have been the lumen of the gut, until the sections were teased apart. Here too, the plicæ circulares seemed quite redundant.

To postulate an early embryonal misplacement of entodermal epithelial cells in the wall of the gut, with their subsequent secretions forming a cyst, seems necessary to explain the origin of this tumor. The gradual bulging of this cystic mass, this "neoplastic plica circulares or valvula conniventes" might then become sufficient to create an obstruction large enough to occlude the lumen of the gut, receiving its nourishment through a very fine, short pedicle from the gut wall. Such a process could go to completion without the production of symptoms only in the fetus. While we have not been able definitely to demonstrate this pedicle of origin, such an explanation satisfactorily accounts for the cysts and their complicated structure.

LITERATURE

1. Roth. Arch. f. path. Anat., etc., Berl., lxxxviii.
Wyss. Ibid., li., 51.
Nasse. Arch. f. Chir., xlv.
Colmers. Arch. f. Chir., lxxix.
Ruge. Ztschr. f. Geburtsh. u. Gynaek.
Beneke. Cit. by Niosi, Arch. f. path. Anat., p. 190.
2. Ewing. Neoplastic Diseases, p. 952.
3. Ziegler. General Pathology, 11th ed., p. 487.

CONGENITAL CYST OF THE DUODENUM

Report of a Case

By OLIVER S. WAUGH, M.D., C.M., F.A.C.S., Winnipeg, Manitoba
Associate Professor of Surgery, University of Manitoba

In medical literature there are surprisingly few references to congenital cysts of the gastro-intestinal tract. Apart from Meckel's diverticulum, the most frequent site of congenital abnormalities in the small intestine is the duodenum; such abnormalities are usually atresias.

Meyer (1), in reporting a case in many respects similar to the one herein described, reviews the literature on this subject. Much of what follows is taken from his paper. Lexer's (2) case was described as representing a bigerminal implantation; Sanger and Klopp (3), in reporting a case of multiple cysts, classify such cysts in three groups: (a) cysts of the accessory liver, (b) cysts of the accessory bile duct. (c). In this group they assume, contrary to Roth, that the cysts originate through a lateral construction of a piece of intestinal anlage, occurring above the omphalomesenteric duct. These lateral constrictions become separated from the main tube of the intestine and, unhampered by the outgrowths of intestinal loops, they remain near the diverticulum and are thus formed from the duodenum. Meyer concludes that his cyst belongs to group (c).

Gfeller (4) calls these tumors entodermoids because they originate from the entoderm. Beneke (5) had already used the term, but in a narrower sense, to distinguish between those cysts originating from aberrant nuclei of the intestinal tube and those developed from the remains of the omphalomesenteric duct, to which he limits the term "enterocystoma." In addition to the above literature on enterocystoma, Meyer mentions that Puschmann, Buchwald, Anderson, and Nasse have described cases showing characteristics similar to those of his case, and he states that if the names of Kuzmick, Levy, Roenger, and Sprengel be added to this list, the literature on the subject is practically exhausted.

Lewis and Thyng (6) found that intestinal and bile duct diverticula occur regularly in the embryos of the pig, rabbit, and man, also in the cat and sheep. They state that they usually degenerate, sometimes forming detached cysts.

The term "enterocystoma," as used by Rokitansky, corresponds to the definition given by Roth: "A congenital cyst is one the wall of which corresponds more or less completely to the structure of the intestinal canal, and the genesis of which is referable to irregular development of the intestinal tube." Undoubtedly, the tumor this description usually fits is the omphalomesenteric cyst, formed by the irregular closure of the omphalomesenteric duct.

Classification, up to the present, includes (1) Sanger and Klopp's three groups, (2) entodermoids, and (3) enterocystomata—enterocystomata as a term including all of these.

The case herewith described has certainly no relation to the omphalomesenteric duct, but, I think, may be classified as an enterocystoma, in its broadest sense, of the duodenum.

G. A., female, age 19 days, born of Icelandic parents in the obstetrical ward of the Winnipeg General Hospital, January 9, 1922. It was an unusually easy confinement for a primipara at term. Both were discharged from hospital on January 19, in good condition. Almost as soon as the mother went home she noticed that the baby began to regurgitate a little milk after each breast feeding. The regurgitation soon increased in amount and came on immediately after each feeding. Sleep at first was undisturbed, but as hunger increased from the continued regurgitation crying became continuous. The bowel movements became irregular, the baby lost weight, and, on January 28, she was brought to the Winnipeg General Hospital, as the mother by this time was convinced that all food taken was vomited. The bowels had not moved since January 26—2 days. The baby was immediately admitted to the hospital and soon after admission passed a small, normal looking stool. The history of recent passage of flatus was in-

definite. A bowel irrigation brought away a small, normal looking stool. All food was vomited precipitately as soon as taken. Temperature 98.6; pulse 100; respiration 35. Diagnosis by the physician sending the case to the hospital was intussusception.

Physical examination revealed a baby who had lost a moderate amount of weight. Crying was continuous. The abdomen was slightly distended and somewhat more prominence was seen in the right hypochondrium than elsewhere. It was difficult to palpate the abdomen on account of crying, but it did not seem to be tender, and on inspiration was quite soft all over. A firm, indefinitely rounded mass could be palpated on the right side of the abdomen extending from the iliac fossa to the costal margin and across the right hypochondrium to the mid line. A tympanitic note could be elicited over the whole abdomen. Rectal examination was negative. Leucocyte count, 8,200. On examination under an anæsthetic the abdomen was found to be quite soft, and in the region described above an even, firm, rounded mass could be felt extending from a little below the crest of the ilium to the inferior surface of the right lobe of the liver and reaching to, but not across, the mid line. The baby obviously had a high obstruction of the bowel, with no peritonitis. The nature of the mass was problematical; it seemed too large and not firm enough for a hypertrophied pylorus. Its shape, comparative lack of constitutional symptoms, and absence of any signs in the stools were against an intussusception. Of congenital deformities, the possibility of a tumor in the right hypochondrium, obstructing the duodenum by its pressure, suggested itself, but no definite opinion as to the nature of this tumor could be formed.

Operation, January 28. The abdomen was opened through the right rectus muscle above the umbilicus. Both large and small bowel were normal, showing that the obstruction was not complete. The gall bladder was normal. Presenting on the outer side of the colon was a cystic mass about the size of a tangerine orange, displacing the ascending colon, hepatic flexure and transverse colon forward. No evidence of peritonitis was present. The peritoneum on the outer side of the hepatic flexure was incised, and a cyst, which was definitely retroperitoneal, was shelled out as far as the mid line, where it was found to be intimately connected with the posterior wall of the duodenum and abutting against the head of the pancreas. As the duodenum was followed downward from the pylorus, it was seen that the first part seemed to run into the upper aspect of the cyst and the third part to emerge from the lower part. The intervening portion of duodenum was discerned, on close examination, to be stretched like a ribbon across the anteromedial aspect of the cyst wall. The association between the cyst and the duodenum was so intimate that it was impossible to think of dissecting them apart. The cyst itself was semitransparent, like a hydrocele. The pressure of the cyst on the first and second parts of the duodenum was obviously the cause of the obstructive symptoms. A small incision was made in the wall of the cyst on its outer aspect, well away from the duodenum, and a clear, straw-colored fluid evacuated. The cavity of the cyst did not communicate with the lumen of the bowel. After excising a small portion of the cyst wall at the site of this incision, for examination, the cavity was packed with gauze. The abdomen was closed with through-and-through sutures and the strip of gauze packing secured.

The packing was removed on February 2, and a tube inserted into the cyst cavity. On February 6, the tube was forced out some time between dressings, and the sinus could not be found to reinsert it, so it was left out. The discharge was never copious and never bile-stained. Recovery was interrupted by occasional attacks of vomiting after food, but this gradually ceased and the baby was discharged in good condition on March 8, weighing 7½ pounds, a gain of half a pound since admission.

Dr. Boyd, the pathologist, reported on the fluid from the cyst and the specimen from the wall of the cyst as follows: "Fluid. No bile, no urea, and no ecchinococcus hooklets present. Tissue. This consists of a well-marked inner circular and outer longitudinal muscular coat."

On March 15, 1922, the child was readmitted with symptoms similar to those present in January, but not so severe. A small mass was palpable in the abdomen where the cyst had been. Added to this there was present a very severe acute bronchitis. Temperature 103.5 degrees; pulse 130; respiration 40. There was evidently a recurrence of the former condition, but the chest complication made surgical interference very unsafe. Operation was delayed until March 22, when it was apparent that the baby was going down hill rapidly from the gastro-intestinal obstruction, and the chest condition was only slightly improved. The extreme gravity of the case was explained to the parents, and they wished the operation to be done.

Operation March 22. The abdomen was opened through the old incision and a recurrence of the cyst found. The cyst was evacuated as before and its wall sutured to the aponeurosis of the abdominal wall, a tube inserted into the cavity and the abdomen closed with through-and-through sutures.

The baby became rapidly worse and died of bronchopneumonia on March 28, 1922. Postmortem examination was not permitted by the parents; indeed, the body was removed from the hospital with such dispatch that there was not even an opportunity to explore the affected region through the wound of operation.

The observations at operation were necessarily hurried. At the first operation, when the discovery was made that it was impossible to separate the cyst from the duodenum with

any degree of safety, no attempt was made to separate it from the head of the pancreas, but it was concluded that the condition being dealt with was that of a congenital pancreatic cyst and it was treated as such. If at that time the cyst wall had been sutured to the abdominal aponeurosis, I feel sure that the recurrence of the cyst would not have taken place, but as this seemed to involve considerable deformation of the duodenum it was decided merely to pack the cavity.

The pathological report on the structure of the cyst wall suggests very strongly that the cyst originated in connection with a muscular tube in this vicinity. This forces the consideration of the common bile duct, the pancreatic duct, and the duodenum itself. There is not sufficient evidence to discriminate between these three, except that the thickness of the muscular layers of the cyst wall were almost what one would expect to see in the wall of the small intestine. What is certain is that it was a cyst derived either directly or indirectly from the duodenum. In all probability it resembled the one described by Meyer.

REFERENCES

1. Meyer, Curt. Ein Beitrag zur Kenntnis der Enterocystome im Sauglingsalter. Ztschr. f. Kinderh., Berl., 1919, xxi, 272–283.
2. Quoted by Meyer.
3. Quoted by Meyer.
4. Quoted by Meyer.
5. Quoted by Meyer.
6. Lewis and Thyng. Am. J. Anat., 1908, vii, 505.

CONGENITAL HEMIMACROGLOSSIA, WITH DISTURBANCE OF THE LOCOMOTOR APPARATUS OF THE SIDE OPPOSITE THE LINGUAL LESION.

By J. N. ROY, M.D., F.A.C.S., Montreal, Canada
Associate professor at the University of Montreal; Laureate of the Academy of Medicine of France

AFTER having made in several languages, numerous bibliographic researches on the subject of which I am about to treat in this communication, I believe that I may say that the following observation is unique of its kind. If we know that the acquired macroglossia manifests itself as the result of inflammatory lesions of the tongue, diathesic or others, it is not the same with regard to congenital macroglossia, the cause of which has always been unknown to us. My patient was very interesting from several points of view, in the sense that the case was one of congenital hemimacroglossia, accompanied by hypertrophy of the corresponding cheek, and troubles of the locomotor apparatus of the side opposite the lingual lesion. This association of symptoms particularly attracted my attention, up to the point of inducing me to advance a hypothesis to explain by a unique lesion, all the phenomena observed. The history of my patient follows.

On November 26, 1919, Mrs. C. L. who came from Gaspe, asked me to make an examination of her daughter, three and one-half years of age, for a lingual affection dating back to childbirth. She informed me that at that time her baby weighed 12½ pounds and that although the doctor was not obliged to apply the forceps or to practice version, the confinement was very laborious. The cord, very voluminous, was long and rolled around the neck. The face was cyanosed, and the tongue, blackish in color, hung out of the mouth. In order to reanimate the infant, the doctor had to resort to artificial respiration for several minutes. The left cheek was more developed than the right, and it fell lightly on the corresponding lower jaw. There existed certain phenomena of atrophy and paralysis of the upper and lower limbs of the right side which, for the present I leave to the appreciation of the consulting physician. During the five following weeks, the tongue slowly diminished in size and recovered its normal color. However, always very large, it protruded from the lips for about 2 centimeters, and after a lapse of time that condition seemed to remain stationary. The left cheek also became smaller by degrees, but remained projected a little more than the right. The child took the breast with some difficulty.

Six weeks after the birth of the child, the parents went to consult Dr. Mireault, orthopedist of Montreal, who was at that time holding his summer clinic on the shores of the Gulf of St. Lawrence, and sought advice in relation to their infant's hemiplegic trouble. My excellent confrère, who subsequently sent his little patient to me for the lingual treatment, was good enough to furnish me with the following notes in relation to his specialty.

"At the examination, I noticed that the upper limb and the lower limb of the right side were smaller and shorter than those of the opposite side, which were normal. The arm rested inert along the body, and the leg was without movement. The tissues lacked firmness in the paralyzed regions.

"In that part of Canada, nature offers the greatest advantages for the restoration of health, but civilization has not yet carried its progress there; hence we have not yet the assistance of electricity there, either for diagnosis or for treatment.

"The doctor who assisted at the confinement, and whom I met a few days after my first examination, declared to me that he did not find granulations in the membranes, or placental tissue.

"The father and mother, who were both about 30 years of age, are in excellent health, and do not indulge in alcoholic liquors.

"There does not seem to be either syphilis or tuberculosis in their family.

"They have two other children, both in good health, and whose confinements were normal.

"In face of these symptoms, once a week, I carried on massage accompanied by passive movements of the paralyzed limbs. This treatment was practiced for 3 months, and at the end of that period, a slight mobility manifested itself. The following year I noticed a progressive amelioration. The child could now move the arm and leg. However, these limbs had not yet attained the vigor of those on the opposite side. During this season, as well as during the two following summers, massage and passive movements were continued. I noticed a gradual diminution of the troubles of the locomotor apparatus to the right. The child commenced to walk at the age of 18 months, and when 3½ years old, could run and jump. However, her walking is a little defective, for there is a slight lameness. During the whole period of her orthopedic treatment, I never observed spasms or contractions, and the articular movements were executed in their normal amplitude and without pain. There always existed a slight shortening of the right arm and leg, as well as a certain degree of atrophy. These phenomena, with a little natural feebleness of the arm, will be permanent in the future. The tongue and cheek are the only two parts whose condition seems to have remained stationary during the last 3 years."

At my examination, I ascertained, in addition to the symptoms already described, that this girl, having always breathed the pure and saline air of the Gulf of the St. Lawrence, is for her age perfectly developed. The skull, of ordinary size, is well formed, and the child's intelligence is above the average.

Her mother informed me that from time to time the child had sudden changes of humor, and even violent fits of temper. However, these cerebral phenomena are becoming less and less frequent. She has never had convulsions.

The left cheek is a little larger than the right, at the same time, being very firm. There is no facial paralysis. The pupils are normal and there is no nystagmus. The hearing is excellent on both sides. The tongue, very thick on the left side, is deviated to the right, and constantly hangs out of the dental arcades to a length of nearly 2 centimeters. Its hypertrophy is uniquely localized on the left side, and continues to the base. Of normal color, it is a little rough to the left, and presents on that side a firmer consistence than on the other. There are no sublingual varicose veins, and the teeth have not produced any ulceration. The inferior lip is lowered without being increased in size. The teeth are well implanted, and the gums show nothing out of the ordinary. The submaxillary glands are not hypertrophied.

The parents have never attempted to force the tongue back into the child's mouth and hold it there by means of a bandage. Moreover, that organ could not be contained in the buccal cavity. Saliva oozes from the mouth slowly. There is no paralysis of the muscles of the tongue, and the taste seems to be normal on both sides. No pain has ever been felt. The tonsils have not increased in size, and nasal respiration is excellent. The roof of the mouth is normal. Mastication is strongly impeded, but swallowing is accomplished relatively well. Phonation is a little troublesome.

In presence of this congenital hemimacroglossia, which seemed to have remained in a stationary condition for 3 years, I immediately proposed the ablation of a part of the hypertrophy as being the most rational treatment. The accepted intervention was fixed for November 29.

Operation. The little patient was put under the influence of chloroform, and I immobilized the dental arcades with a mouth-gag. The tongue-forceps were afterward applied to the end of the tongue—one of them being held by an assistant—and after having practiced a light traction, I divided the organ by means of a pair of scissors for the length of about 5 centimeters in following the middle raphe to the left. Once the tongue was separated in two, the affected side being longer than the healthy side, I removed a V-shaped piece in order to re-establish the symmetry. The section commenced on the left external part, at a certain distance from the tip, and continued toward the base on a line of 4 centimeters. After having controlled the hæmorrhage, which was insignificant, I made a series of sutures commencing at the wound on the floor of the mouth. When all the points were placed, I applied a last transversal suture having the form of a U

properly to coapt the middle part. At this time the tongue entered the mouth perfectly, and its tip, which was drawn neither to one side nor the other, maintained its regular anatomical design.

As a buccal antiseptic, I prescribed a solution of resorcin to be used with an atomizer.

The outcome of the operation was normal, and after several days of lingual reaction, the œdema disappeared gradually. I commenced to make the ablation of the sutures at the end of the first week, and on the eleventh day, they were all removed. Three weeks after the intervention, the girl, thoroughly re-established, returned home with her mother. The left side of the tongue was still a little larger than the right; however, its volume diminished little by little.

The anatomo-pathological examination of the piece that was removed showed that we were in the presence of a hemimacroglossia of lymphatic form —a microscopic variety most generally observed in this kind of lesion of congenital macroglossia.

From time to time I received news of my little patient, and in June, 1922, the left cheek was of almost equal volume to that of the right cheek. The left side of the tongue was slightly larger than the right; however, it was quite mobile and easily contained in the mouth. Considering the age of the child, her pronunciation was as good as could be expected, and her temper was improved.

As it is now a little more than 2½ years since the operation was performed, I have every reason to believe that there will not be any relapse of the lingual affection.

The upper and lower limbs of the right side are still slightly shorter than those of the left, and at the same time present a little atrophy. These troubles will never wholly disappear in the future.

To sum up the case, a child, born of parents enjoying the best of health, without any diathesis, has at birth a hemimacroglossia to the left, accompanied by hypertrophy of the corresponding cheek, and paralytic phenomena of the locomotor apparatus on the side opposite to the lingual lesion. After the operation the tongue and cheek returned to an almost normal condition, but the motor troubles of arm and leg, though very considerably improved, did not entirely disappear.

If now we stop to consider the cause of this strange disease, we see that in the orthopedic domain the etiological factors of the locomotor troubles of newborn children can give rise to very different interpretations, according to their localization.

Lesions of the nervous system are more serious than articular lesions, and the contusions of the muscles do not give a prognosis as serious as in the case of epiphyseal tearing. Affections of newborn children resulting from abnormal conditions during the intra-uterine life manifest themselves at birth, or in the first days after confinement. Tissues in the course of growth are very vulnerable, and their power of resistance is less during intra-uterine development than on the nursing child.

Our slight knowledge of fetal life does not give us an entire comprehension of abnormal phenomena, mechanical or nutritive, which have for result a being infirm or deformed when brought into the world.

There are three classical types of congenital paralysis. The whole three affect only the arm. The first paralysis attacks the entire arm; the second, that of Klumpke, settles in the forearm; and the third, the paralysis of Erb, occupies the upper region, the latter kind being much more frequent. But apart from the present instance, we have never yet observed a case of congenital paralysis of the lower limb.

The totally transitory paralytic character of the troubles of the patient in this case, inclines me toward two etiological factors: either a bulbar capillary hæmorrhage, or in the nervous trunks: or else a traumatism of the articular capsules due to a slight and prolonged traction on that membrane by an exaggerated flexion during the last days of intra-uterine life. Nevertheless, I must say that the arm and leg both participated in the state of paralysis, that there was neither contractions nor bad positions of the limbs, and that symptoms of pain were absent.

As to epiphyseal tearing, it must be eliminated.

The cause of congenital macroglossia is not yet known.

In my case, I believe the hemimacroglossia can be attributed to the same etiological factor as the affection of the locomotor apparatus. Indeed, if we had been in the presence of a cerebral lesion, there would have been the phenomena of contraction, pain, and sensory

troubles. None of these was present, and more than that the intelligence remained lively, the character became normal, and physical development followed the ordinary course of growth.

With a meningeal œdema, there would probably have been persistent lesions being connected with a diathesis.

Consequently, in the presence of the association of symptoms observed in the case of my little patient, I consider I found sufficient elements to justify the hypothesis of a bulbar capillary hæmorrhage in the region of the nuclei of the seventh, twelfth, and ninth cranial nerves on the left side, a lesion which determined trophic disturbance of the tongue and cheek, accompanied by divers troubles, transitory or permanent, of the upper and lower limbs on the side opposite the lingual affection.

CHANGES OF PRESSURE INSIDE THE FETAL CRANIOVERTEBRAL CAVITY

By BRONSON CROTHERS, M.D., Boston

IN 1861 Little presented clinical evidence to support a theory that some of the mental and physical defects of children were due to injuries of the central nervous system during delivery. This evidence has never been challenged and no one now questions that a considerable proportion of all the defective and crippled children who fill institutions and form a discouraging group in every out-patient department owe their disabilities to accidents during birth.

Furthermore, it is unnecessary to call attention to the fact that babies can be killed by efforts to deliver them by force through passages too narrow to allow spontaneous expulsion. The possibility that accidents may occur under conditions producing recognized dystocia is admitted. The fact which has not received general recognition is that babies can be, and frequently are, seriously and even fatally injured even if the forces used in delivery are well within what are regarded as normal limits.

In this paper I wish to present the evidence which has convinced me that the process of successful childbirth depends, to a very great extent at least, upon the preservation of barriers which prevent the forces imposed upon the fetus from injuring the central nervous system. In normal labor pressure is controlled so that danger is averted. Unusual forces, chiefly due to abnormal conditions or to obstetrical interference, may break down certain barriers which usually control pressure in an orderly way. The discussion which follows is limited to conditions generally regarded as normal. That is, I assume that the fetus is at term, that there is no serious disproportion between the size of the fetus and the pelvic canal, that the mother is strong and is threatened by no condition which forces the attendant to interfere in her interest. I also assume that the presentation is either vertex or breech.

THE CONDITION KNOWN AS ASPHYXIA NEONATORUM

Babies sometimes perish during or shortly after delivery. The discovery of the causes of such disasters is of cardinal importance. The conventional explanation, upon which obstetrical procedure appears to be based, is that the majority of babies die of asphyxia. Therefore, as soon as signs of fetal distress are observed the obstetrician interferes in order to deliver the baby before it is suffocated. This procedure is perfectly logical if either of two facts is known: First, there might be evidence that fetal life is frequently saved because delivery is hastened. This evidence is almost impossible to gather because no sensible operator would be justified

in disregarding accepted traditions in order to observe possible results. Second, the strong probability of asphyxia might be demonstrated. This problem could, of course, be worked out by a suitable series of experiments which would establish standards of resistance of fetal cells to varying tensions of oxygen and of carbon dioxide. It would then be a relatively simple matter to find out whether the blood of babies, believed to be asphyxiated, showed chemical changes consistent with the diagnosis. As far as I know such studies have not been attempted.

The obstetrical conception of asphyxia appears to rest entirely upon speculations and deductions. Neither in books nor in conversation with obstetricians have I been able to find references to any scientific data which bear upon the subject. Naturally if placental circulation is cut off and the baby is left inside the uterus for an indefinite time, asphyxia may be assumed, just as it may be assumed that any tissue will eventually die if it is deprived of oxygen supply. The question at issue, however, is not so simple. It is, will a fetus possessing an independent and functioning apparatus for circulating its supply of blood, perish from asphyxia, under conditions met with during birth, if the placental circulation is cut off for a period of a relatively few minutes? As a matter of fact a further question is perfectly legitimate. Is there evidence that the placental circulation is cut off in all, or almost all, of the babies where the diagnosis of asphyxia is made? Two quotations from standard textbooks may be given. The first describes the conditions one author includes under asphyxia. The second shows the explanation which another author relies on in supporting his theory.

Edgar defines the condition as follows: "Blue asphyxia is characterized clinically by a livid redness or blueness of the face and upper parts of the body. The face is turgescent and the eyelids are prominent and injected. The muscles of the extremities, neck, and jaws are rigid, and the heart action is strong. In children thus born the cord is found to pulsate strongly. The reflexes and sphincters behave in a normal manner. Children born with blue asphyxia may recover promptly or only after a considerable interval, or the condition may pass into the white or anæmic form. Here the condition superficialy present in blue asphyxia appears to be inverted. The surface is pale, instead of livid. The face is pinched. The muscles are all relaxed. Circulation is at a standstill, and not only is the heart beat difficult to recognize, but there is no escape of blood when the surface is incised. Children born with white asphyxia have a small, almost pulseless cord."

Williams states that the normal supply of properly aerated blood may be cut off by any one of various accidents while the child is still in the uterus or the pelvis. "As a result of the action of any of these factors, the child may take its first breath while still in the uterus or in the lower portion of the birth canal. In the former case it draws a certain quantity of amniotic fluid into its lungs, unless such an eventuality is rendered impossible by the fact that the nose and mouth are closely applied to the uterine wall or are covered by the fetal membranes. When respiration begins while the head is in the vagina, a certain amount of mucus is liable to be aspirated. In either event the needed oxygen is not obtained, and the resulting air hunger leads to increased respiratory efforts which are nevertheless of no avail. Gradually the accumulation of carbon dioxide and other excrementitious materials in the fetal organism leads to such a pronounced decrease in the irritability of the medulla, that eventually the attempts at respiration cease, the intervals between the pulsations of the heart become longer and longer, and the child dies from asphyxia.

"Again pressure exerted upon the brain in difficult labors and operative procedures may lead to vagus irritation and consequent slowing of the heart. As a result of the interference with the fetal circulation, the blood becomes poorer in oxygen and richer in excrementitious material; this goes on until at last the irritability of the medulla becomes so lowered that the usual stimuli fail to call forth the first respiratory movement and asphyxia results."

It is quite evident that the single point of resemblance between blue asphyxia and white

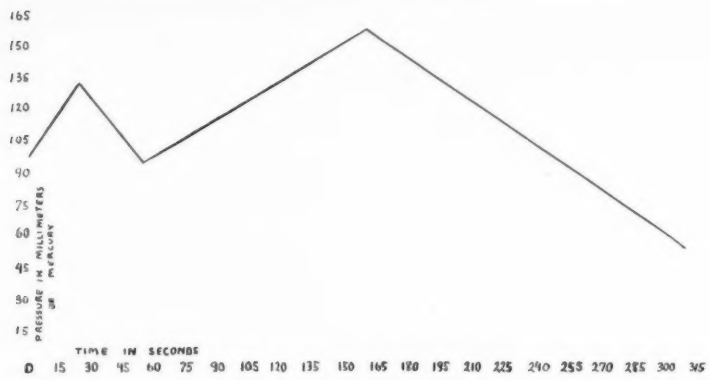


Fig. 1. Blood pressure after experimental occlusion of cerebral circulation. (From Stewart, Guthrie, Burns, and Pike.)

asphyxia is the fact that in both cases the babies are apnœic. Of course perfectly normal new-born babies, of ordinary color, are often apnœic for some time. It is worth while to consider for a moment what logical explanations, aside from those stated by Williams, can be given for failure to take a first breath after delivery. One obvious way to reduce the excitability of the medulla is to give certain drugs, notably opium or anæsthetics. Naturally such drugs given to the mother during delivery might account for certain cases of apnœa in the fetus. But by far the most certain method of producing lack of irritability of the medulla is to attack it directly in any one of a number of ways. The simplest is by direct injury or by increasing pressure in its vicinity so that the circulation about it is cut off. An equally effective method is to shut off circulation by ligation of vessels.

Obviously experiments which produce apnœa in animals after respiration is established are not conducted under circumstances identical with conditions which prevent fetal animals from starting to breathe, but they are at least comparable.

Blue asphyxia, as I understand it, is readily enough explained. The baby, for any one of a number of reasons, has a medulla which is less irritable than usual. As a result it requires more stimulation before taking a breath. This stimulation is automatically provided, as the carbon dioxide increases and the oxygen diminishes, until respiration starts. Apparently uncomplicated blue asphyxia is not usually serious. White asphyxia, on the other hand, is a condition which occurs at no stage of suffocation in extra-uterine life. It can be almost exactly duplicated, however, by interference with the medulla or the phrenic nuclei. The clearest description of the results of putting the medulla out of action is given by Stewart, Guthrie, Burns, and Pike. They rendered the brain and upper cord totally anæmic by suitable arterial ligations,—as a result "the nose and the mucosa of the mouth become white as in death, respiration ceases, the reflexes disappear and the pupils dilate completely. The art is but little affected," the blood pressure first rises and then falls to a low level for the duration of the experiment. (Fig. 1.)

The observations of Stewart, Guthrie, Burns, and Pike and those of Gomez and Pike indicate that the cells of the cerebral cortex resist total anoxæmia for about 10 minutes and those of the medulla for 20 minutes. Cannon and Birket demonstrated that the nerve cells of the myenteric plexus survived and were functionally undamaged after total anæmia lasting for hours. All these experiments were made on adult animals. In the light of Crile and Dolley's work, it is reasonable to suppose that the tissues of young animals are even more resistant.

As I shall attempt to show, the viability of the fetus depends on the integrity of the cells of the medulla and upper cord. If this assumption is valid it follows that the fetus can survive after at least 20 minutes of complete anoxæmia, for it is generally recognized that the other vital tissues survive longer than those of the central nervous system.

THE FORCES IMPOSED UPON THE FETUS

The evidence which I wish to present consists of pathological, physiological, and clinical observations. The injuries at birth are, of course, due to the failure of fetal tissue to resist the forces imposed upon it. It is, therefore, necessary to consider the forces involved and the resistance of the fetal structures upon which they act. The forces are well understood. In normal vertex deliveries, the head is driven into the pelvis and against the more or less rigid soft parts. The only force is pressure. Until the rupture of the membranes, this pressure is uniform; after the escape of the amniotic fluid there is, of course, a distinct difference between the pressure over the portion of the fetus within the uterus and that occupying the os. This difference leads to the formation of the caput succedaneum.

If delay occurs the pressure from above is reinforced by artificial aid. The use of forceps must add a little to the compression of the head. In general, however, it is presumably possible to use forceps without introducing any new type of force. In spontaneous breech deliveries the maternal force is pressure as before. The head, instead of molding slowly, comes suddenly to the superior strait and is forced through it without preliminary adjustment. On theoretical grounds, trouble would be expected. Practically there is good reason to regard breech presentations as dangerous. The forces which are brought to bear, if delay renders interference desirable, are two: First, direct pressure upon the fetal head. This suprapubic pressure is often intense and may be exerted continously over a considerable period. In addition, traction upon the legs or the body of the fetus may be applied. Traction is a totally unphysiological procedure, exerted on tissues ordinarily subjected to compression.

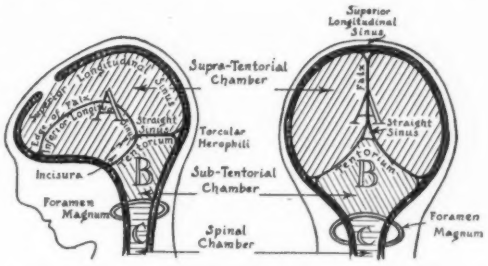


Fig. 2. Sagittal and coronal sections to show venous channels and arrangement of dural septa.

THE FETAL STRUCTURES SUBJECTED TO STRESS IN DELIVERY

The fetal cranium consists of two divisions which are quite distinct from the point of view of resistance to the forces of labor. The flexible plates of bone forming the vault are loosely bound together and form an elastic covering for the cerebrum. The base, on the other hand, is relatively rigid and essentially incompressible. It is easy to demonstrate this difference on any fetal cadaver. The details of this and of other mechanical factors are adequately given by Holland. (Fig. 2.)

The intracranial cavity is divided into three chambers by the dural septa. The cerebral hemispheres are partially separated by the falx which sweeps back from the crista galli of the ethmoid to a strong insertion in the median line of the tentorium. The tentorium forms a sharply pitched roof for the posterior fossa. It arises along the line where the flexible plates forming the vault meet the rigid bones of the base. It is pierced by the opening occupied by the mid brain. The falx and the tentorium may be considered in any one of three different ways: First, as membranes carrying blood vessels. Practically every large venous channel runs along the insertion or through the substance of one or the other membrane. Second, as Holland clearly points out, as strong double layers of fibrous tissue reinforced by bands of fibers which are put under tension as soon as the head is changed in shape; they thus resist cranial distortion. Third, as means to control intracranial pressure.

The spinal column of the infant is composed of a series of cartilaginous, elastic rings held

together by relatively inelastic and fragile ligaments. The elaborate and strong interlocking bony processes of the adult spinal column are undeveloped. The length of the column can be altered about 2 inches by stretching or compressing the fetus between the hands.

The spinal dura is adherent to the vertebræ in the cervical and lumbar regions, while between the two it is almost unsupported except by slender bands of connective tissue accompanying the fragile thoracic roots. These various structures form the walls of the craniovertebral cavity. Above, the two supratentorial cavities, separated by the incomplete septum of the falx, are compressible to a very marked degree. The subtentorial chamber is small, and almost fixed in size and shape. No serious change in its capacity can occur unless ruptures of the falx or the tentorium allow collapse of its roof. The spinal chamber is an extensible tube, the caliber of which cannot be appreciably diminished because it is held to the walls of the vertebral canal by fibrous bands.

The supratentorial contents consist of the two cerebral hemispheres. These masses of gelatinous material contain a small amount of ventricular fluid. The opening in the tentorium is almost completely filled by the mid brain. The posterior fossa contains the pons, cerebellum, and medulla. The relations of the medulla and cerebellum to the foramen magnum are of particular interest. Under ordinary conditions, the medulla and cerebellum are kept from contact with the margins of the foramen by fluid in the subarachnoid space, which is dilated to form the cisterna magna. The foramen itself is slightly larger than the medulla. The spinal cord is continuous with the medulla. In the neck it is supported by the strong, horizontal, closely spaced roots of the brachial plexus. The cauda equina forms a powerful lower anchorage. Between the two fixed points, the slender thoracic cord is supported by the thin oblique roots of the thoracic nerves.

PHYSIOLOGICAL CONSIDERATIONS

The various portions of the central nervous system are of very different value as far as the maintenance of life is concerned. Certain routine physiological experiments will illustrate this point. An animal can be decerebrated by section at the mid brain. The animal lives indefinitely without artificial respiration. From such a decerebrate preparation, the cerebellum can be removed without causing death. However, if the medulla is injured, even by as slight an accident as leakage of blood around it, respiration may cease. In general any severe injury involving the medulla or the upper segments of the spinal cord is fatal on account of injury to the respiratory centers or the phrenic nuclei. Section of the cord below the level of the phrenic nuclei produces the so-called spinal animal. Reflex activity is possible, though voluntary activity and sensation are abolished below the level of transection.

These observations have a direct bearing upon obstetrical problems. As long as the fetus receives oxygen from the placenta it has no need of a central nervous system. Within a measurable time after the cessation of placental circulation, it must be delivered, or be otherwise provided with air, with an excitable medulla and an intact upper cord. It can survive for an indefinite period without any activity of the lower cord, the cerebellum, or the cerebral hemispheres. The viability of the child, then, depends on its delivery without asphyxial or traumatic damage to the medulla or to the phrenic nuclei.

If the intense and irregular forces imposed upon the vertex of the fetal head reached the medulla without modification that cone of vital tissue would be driven against the anterior margin of the foramen. I believe that the tentorium and the falx serve an important function in preventing this impaction of the medulla.

Leonard Hill published, in 1896, a series of observations which tended to prove that pressure within the craniovertebral cavity was not always uniform. His observations were supported by Cushing and by Wolbach, among others. According to this theory of discontinuity, pressure imposed upon the cerebral hemispheres is partially absorbed by the resistance of the brain tissue. Next it is trans-

mitted to the ventricles. The fluid in the ventricles is displaced and flows into the posterior fossa through the aqueduct. Continued pressure after the evacuation of the ventricles is transmitted to the walls of the supratentorial cavity, of which the tentorium, of course, is one. The cerebral hemispheres no longer transmit pressure according to the laws governing fluid pressure in a rigid container, as there is no considerable amount of free fluid above the tentorium.

The subtentorial chamber is relatively constant in size. However, the initial yielding of the tentorium probably decreases its volume a little. Further, the addition of the appreciable amount of fluid forced from the lateral ventricles adds to the contents of the chamber. The result, of course, is a rise of pressure.

One well-recognized result of intracranial pressure is the descent of the medulla and cerebellum into close contact with the margins of the foramen magnum. This results in narrowing of the subarachnoid spaces between the posterior fossa and the spinal canal. Sudden or severe increase of pressure may result in complete obliteration of the subarachnoid spaces and impaction of the cerebellum and medulla. Under these circumstances the medulla may be injured by contact with the anterior lip of the foramen or rendered inexcitable by anæmia from pressure. A similar result will follow sudden reduction of spinal pressure. This disastrous herniation is seen, occasionally, as a result of lumbar puncture in patients with cerebellar tumors. Without going further into the evidence for discontinuity of pressure, it is enough to point out that, under gross and sudden changes of intracranial tension, the tentorium and the foramen magnum are the two points at which pressure imposed upon the vertex may be modified or completely blocked.

The objections to this theory are obvious. Recent studies of the cerebrospinal fluid have indicated that under ordinary conditions the cerebrospinal fluid pressure is essentially the same as the intracranial pressure. Although the validity of such observations is granted, it is essential to investigate the experimental conditions under which they were made. It is quite clear that data obtained from experiments upon animals with rigid skulls cannot be used, without consideration, in solving problems such as we are considering.

Eyster, who studied the relation of Cheyne-Stokes breathing and intracranial pressure, challenges certain methods of Hill. However, he agrees with him at certain essential points. He has shown that under ordinary experimental conditions pressures become equalized very quickly when fluids are forced into the subarachnoid space. From the point of view of sudden or prolonged pressures, however, his paper contains various pertinent, though incidental, observations. In the first place when, after considerable difficulty, manometers were arranged which registered properly in the various cavities, it was observed that, after supratentorial pressure was imposed, "the pressure over the medulla followed in *a few seconds* the pressure of the entering fluid and a slight pressure remained for a short time over the medulla after removal of the compression over the cortex. When the brain had been submitted to pressure for some time, the agreement between the pressures was not so close, and the pressure that remained over the medulla after the pressure bulb was lowered was increased." (Italics mine.)

Further on he states that "when the intracranial pressure has been kept high for a long period of time the brain may become markedly œdematous. It is possible, under these circumstances, that more or less blocking may occur at the isthmus tentorii cerebelli, or at the craniovertebral junction; the pressure upon the medulla is then indirectly transmitted by crowding the hind brain down into the spinal canal, rather than exerted directly by the compressive fluid. This condition is expressed in the results of the experiments by a lack of the usual close correlation between the effects observed and the relations of intracranial and blood pressure."

That is, he appears to believe, as a result of careful observations under experimental conditions, that pressure even by fluid is not instantly transmitted from chamber to chamber and that definite discontinuity occurs when the intracranial pressure has remained high for some time.

The chief point of physics which is to be considered is this: Fluids completely filling closed rigid containers will transmit pressure equally in all directions and to all points. These conditions are fairly well fulfilled within the craniovertebral canal of animals with rigid skulls and with free communication between the fluids in the various cavities. They are no longer present when the walls of the cavities concerned can be altered in shape and when movement of fluid from chamber to chamber can occur. The technique of Weed and others involved the minimum movement of fluid and the least possible disturbance of physical conditions. Under obstetrical conditions, on the other hand, gross changes of volume and considerable movements of fluid may be assumed. It is almost inconceivable that the compression and molding of the fetal head and the lengthening of the spinal column do not introduce factors which render the direct application of observations under radically different circumstances inadmissible. The very fact that Hill's observations were made on animals subjected to sudden and considerable changes of pressure seems to make them more pertinent than the more delicate experiments of recent writers.

THE PATHOLOGICAL EVIDENCE

The safety of the medulla appears to depend upon the ability of the falx and the tentorium to withstand the forces exerted upon them. The phrenic nuclei are endangered by any injury to the cervical spinal column.

The ruptures of the falx and of the tentorium during childbirth were recognized, at occasional autopsies, many years before Beneke in 1910 called attention to the fact that they were common. Beneke reported many cases and described the various types. The septa usually give way in the neighborhood of the insertion of the falx into the tentorium. The tears may be complete, involving both layers of the tentorium, or partial. Sometimes the free edge of the tentorium gives way, sometimes the tear produces a hole. The falx apparently is rarely torn alone and the free edge never gives way.

Beneke's cases were reported in detail by Pott in 1911. Since then a considerable number of European writers have reported series of cases. Among the best papers are those of Meyer and Hauch and of Holland. By tabulation of these cases totaling about 200, certain facts can be shown. Tears of the dural septa can be discovered, on proper search, in almost half of all babies dying during or within a few months after birth. Usually hæmorrhage accompanies the lesions of the septa. In an important proportion of cases, however, little or no bleeding is found. Some authors found hæmorrhage in only about half the cases, others in 90 per cent. The discrepancies are most easily explained, I think, by the varying degrees of care with which cases were studied. Obviously certain observers regard a rupture as a gross solution of continuity, others include almost microscopic incomplete tears. However, I can confirm, from a very limited series of observations, the fact that tears may be of considerable extent without involving any vessels of importance.

Working from another point of view, it is clear that, in most cases of intracranial hæmorrhage, the source of the bleeding is a torn vessel near a rupture of one or the other of the dural septa. As a matter of fact it is hard to find any other vulnerable vessels of sufficient caliber to cause massive subdural hæmorrhages. Vischer, for instance, performed twenty-one autopsies on babies with intracranial hæmorrhage. In 17, or 80 per cent, he discovered tears of the septa.

The fact of greatest interest, however, is the discovery that about 40 per cent of the ruptures occur in babies delivered feet first. In no article is there anything to suggest that version was used except for conventional indications. It seems fair to assume, therefore, that some 40 per cent of the injuries occurred in 5 per cent of the deliveries, or, to put it differently, that ruptures of the dural septa occur eight times as often in breech babies as in those delivered head first. Holland's statistics, based on 81 cases of rupture, showed that the injury could be found in 88 per cent of dead breech babies born without serious difficulty.

The method by which the injuries are caused seems fairly simple. Experimentally

it is possible to rupture the septa by distortion of the head alone. As Meyer and Hauch showed, rupture is favored if the cavities are packed tightly before distorting the head. Apparently it makes little difference whether pressure is exerted from side to side or from front to back. As long as the head is sharply flexed, the falx is put under even tension. Extension and distortion is apparently the least favorable combination. These observations can be easily repeated on any fetal head. (Fig. 3.)

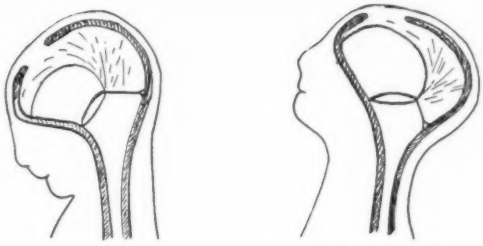


Fig. 3. Diagrams showing the lines of stress in flexion and extension. In extension the incisura is almost horizontal and the strong fibers of the falx are not in the best position to resist strain. At left, flexion; at right, extension.

Beneke made one observation of special interest. He ruptured the tentorium by a sudden blow on the side of the fetal head with a padded hammer. The presumption is that the sudden impact broke the tentorium by much the same mechanism that produces *contrecoup* fractures of the adult skull. A similar manifestation of the importance of impact was seen in an autopsy performed recently at the Neuropathological Department of the Harvard Medical School. A boy of eight was hit on the forehead by an automobile. The skull was not fractured but the tentorium was torn clear into the petrosal sinus.

Meyer and Hauch report one case where a baby was being delivered by cæsarean section. Suddenly the uterus contracted and the head was momentarily caught in the incision. The baby died and a rupture of the tentorium was found.

The relation between rupture and hæmorrhage is important but cannot be considered here. The point I wish to emphasize is that any rupture, however slight, allows the tentorium to descend somewhat, and by just so much decreases the volume of the subtentorial chamber and destroys the rigid barrier to continuity of pressure between the supratentorial and subtentorial chambers. If the rupture occurs early in labor, the medulla is exposed to the direct stress of the irregular forces acting on the fetal head during a considerable period.

The evidence concerning rupture of the spinal column is equally definite, though far less voluminous. C. Ruge, in 1878, reported that 8 out of 64 dead breech babies showed rupture of the cervical spinal column. Scattered reports can be found, but the next considerable series is one by Stoltzenburg in 1911. She found nine cases of rupture of the cervical spinal column out of 75 babies dying of "asphyxia." Eight of these occurred in breech babies. In other words 10 per cent of all the babies dying of "asphyxia" perished as a result of ruptures of the cervical spinal column due to breech extraction. Naturally ruptures of the cervical spinal column are not found unless they are looked for. In this country, at least, the spine is not exposed as a routine in most clinics.

It is obvious, of course, that many cerebral hæmorrhages are not due to dural tears. There is some evidence, however, that even small scattered hæmorrhages throughout the brain may be related to pressure during delivery. This explanation is emphasized by Schwartz. He points out that the caput succedaneum is merely the external manifestation of a movement of fluid which results from the fact that one area of the head is under less pressure than the rest of the fetus. He finds œdema of the tissues, and often hæmorrhage into them, beneath the caput. He has studied a very large number of infant cadavers and reports that in 65 per cent he finds evidence of hæmorrhage, due, in his opinion, to injury at birth.

Traumatic asphyxia, due to compression of the trunk, is interesting in relation to certain injuries in babies. The intense discoloration of the neck and chest, due apparently to capillary stasis, is duplicated in babies. But in babies the delicate blood vessels may rup-

ture, causing intracranial hæmorrhage. This apparently happened in a premature baby described by Ylppö, who, by a series of experiments, established the relation to unequal pressure over head and trunk during labor. Comparison of the plates of his case with those of adult cases presented by Green and by Beach and Cobb is convincing.

If Ylppö's conclusions are correct it is obvious, I think, that compression of the trunk in resuscitation is undesirable. As a matter of fact compression cannot make air enter the lungs until they have been expanded. It is, however, quite probable that many slight intracranial hæmorrhages are increased by active efforts to resuscitate a baby thought to be suffering from suffocation.

The present situation can be summed up as follows: Pathologists have not developed a uniform technique. As their interest focuses on one point, the tentorium, for example, injuries are found in large numbers. If their particular interest is in the study of the phemomena of hæmorrhage, they find that the blood of an extraordinary number of babies is slow in clotting. However, in spite of difficulties in interpreting various articles, it is clear that definite ruptures of the strong dural septa occur in a very important number of cases, that necks are broken with unsuspected frequency in extractions, and that intracranial hæmorrhage, which intelligent and careful pathologists believe to be due to injury, can be found in 65 per cent of all babies dying during labor or in the first months of infancy. However important asphyxia and hæmorrhagic disease may be, for the present there is good reason for feeling that the weight of evidence is in favor of injury as the chief cause of still-birth of viable babies and of death in early infancy.

CLINICAL EVIDENCE

The clinical evidence, of course, is largely indirect. However, certain injuries of the spinal cord produce symptoms so definite that they have a certain value. A study of scattered cases in the literature and one short series I recently reported show that cord injuries follow breech extraction in considerable numbers. The most frequent injury, consistent with life, seems to be in the mid-thoracic region; next come cord lesions resulting from traction upon the brachial plexus.

Beneke made one suggestion in regard to hydrocephalus which is interesting and deserves consideration. He pointed out that hydrocephalus might result from stenosis or thrombosis of the vein of Galen. This suggestion fits in with the experimental observations of Dandy and Blackfan. The latter were able to produce hydrocephalus by ligation, at certain points, of the vein of Galen. They were also able to produce it by placing an irritant ligature around the mid brain. As adhesions blocked the subarachnoid space around the mid brain, hydrocephalus developed. Pathological studies in babies showed that adhesions in this region were frequently present. Dandy and Blackfan believed these adhesions to be the result of meningeal infection. It is possible that some of them were the result of organized blood from tentorial lacerations. Naturally pathological studies with this point in mind will quickly settle the question.

The basal origin of many birth hæmorrhages makes it easier to understand the protean symptomatology of infantile cerebral palsies. The basal ganglia and the mid brain must be frequently involved. Athetosis, flaccidity, and other features of these cases were very difficult to explain on the old theory that the cortex was chiefly affected. In general, therefore, many complicated neurological syndromes in children can be explained on the basis of the pathological lesions which have been recently described. Clinical evidence, such as it is, confirms pathological evidence.

PRESSURES WITHIN THE FETAL CRANIOVERTEBRAL CAVITY DURING NORMAL LABOR

It is possible, I think, to correlate these various observations and to formulate a conception of pressure changes within the craniovertebral cavity of the fetus during labor.

With the onset of labor the fetal head is forced into the pelvic canal. Compression and molding occur. Distortion is limited almost exclusively, to the vault of the cranium. The supratentorial pressure rises, the easily displaced ventricular fluid is forced into the

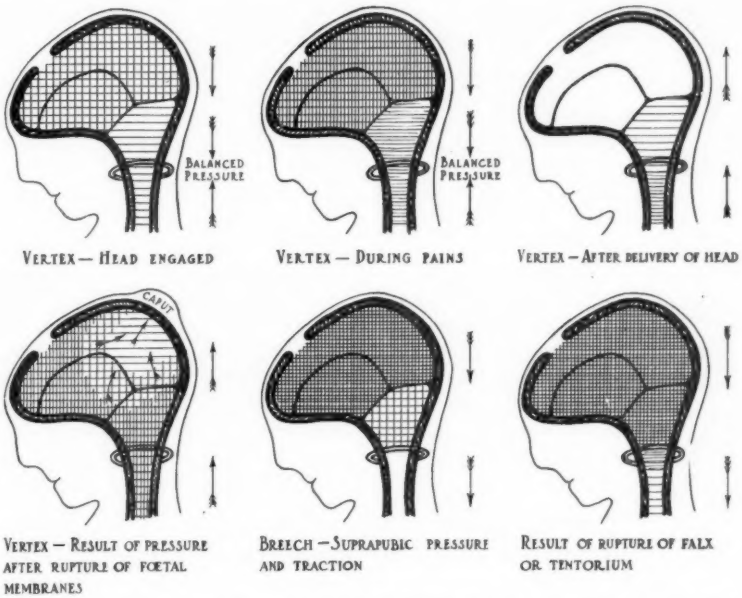

BALANCED PRESSURE
BALANCED PRESSURE
CAPUT
VERTEX — HEAD ENGAGED
VERTEX — DURING PAINS
VERTEX — AFTER DELIVERY OF HEAD
VERTEX — RESULT OF PRESSURE AFTER RUPTURE OF FŒTAL MEMBRANES
BREECH — SUPRAPUBIC PRESSURE AND TRACTION
RESULT OF RUPTURE OF FALX OR TENTORIUM

Fig. 4. Pressures within the craniovertebral cavity of the fetus during normal and abnormal labor. Pressure intensity is suggested by shading; direction of pressure by arrows.

posterior fossa. The cerebral hemispheres no longer contain free fluid and therefore no longer transmit pressure as a fluid. On the other hand any further pressure involves pressure against the walls of the cavity. The vault is forced against the resistant tissues in front of it. The basal bones are rigid. The tentorium alone is relatively fragile and is the only point at which ordinary forces can produce injury.

As the ventricular fluid enters the subtentorial and spinal chambers, pressure is naturally raised. At the same time the forces acting upon the breech cause compression of the spinal column. As a result, a balance of pressure at the foramen occurs. This balanced pressure prevents descent of the contents of the posterior fossa and insures the maintenance of communication between the subtentorial chamber and the spinal chamber. As the pains diminish, the compressed tissues expand and again pressures balance at a lower level. Circulation around the vital cells of the medulla and cord is resumed. Meanwhile the vault is still compressed so that the choroid plexuses can secrete little if any new fluid. As soon as the cervix is fully dilated the rupture of the membranes allows the dilating bag of fluid in front of the head to collapse. New pressure relations need consideration. The part of the head occupying the os uteri is no longer subjected to intrauterine pressure. As a result, the fluids in the fetal body move toward this point. This movement of fluid is manifested by the formation of the œdematous caput succedaneum. Schwartz, who has studied this problem with great care, believes that the caput is merely the external manifestation of a far more important change within the skull.

The successful delivery of a baby who presents head-first, then, depends upon the preservation of the barriers to discontinuity of pressure between the supratentorial and subtentorial chambers and upon avoidance of prolonged or sudden pressures after the rupture of the fetal membranes. The final event, so far as pressures upon the nervous system

are concerned, is the delivery of the head. The flexible plates of the vertex spring back into shape. Supratentorial pressure is relieved. The movement of fluid is upward. The medulla and cerebellum rise from contact with the margins of the foramen, and the baby is neurologically prepared to face an independent existence.

ABNORMAL LABOR

In this paper I purposely omit consideration of recognized types of dystocia due to various abnormal presentations. But I regard breech presentations as abnormal, first, because the fetal death rate is far higher than when the child comes head-first, and, second, because theoretical considerations convince me that dangerous disturbances of pressure are almost inevitable when conventional methods are used in delivery.

The pressure relations during engagement are not radically different from those in babies coming head-first. However, the slow rhythmical compression of the fetal head does not occur. After the breech is born, very definite differences occur. The spinal column is no longer compressed. The head engages very much more abruptly. The ventricles empty suddenly into the subtentorial chamber. As the breech is no longer under pressure, there is no balancing increase of tension in the spinal canal. Downward dislocation of the medulla and cerebellum is, therefore, not automatically prevented. At least, it is obvious that every force is acting downward, that is in the most dangerous direction.

If delay occurs, the obstetrician feels obliged to intervene because the baby is regarded as likely to suffocate. It is argued that the placental circulation is almost certain to be impeded as the engaging head compresses the umbilical cord against the pelvic walls. On the basis of clinical experience certain obstetricians state that delivery must take place within 8 minutes after the head enters the superior strait or fetal asphyxia will cause death. The logical result is early interference.

This interference involves forces which are theoretically dangerous. Traction reduces spinal pressure by elongating the spinal chamber. The arrangement of the fibrous bands attaching the dural sac to the vertebral column prevents corresponding narrowing of its lumen. The result is an increase in the volume of the spinal canal. At the same time suprapubic pressure, often of considerable intensity, is imposed upon the aftercoming head. The downward stream of pressure, inevitable in breech deliveries, is intensified.

Two accidents, both well established by pathological evidence, may occur: first the tentorium may rupture (the suprapubic force is suddenly released upon the medulla); or the cervical spinal column may give way, involving traction upon the vital region of the phrenic nuclei or haemorrhage about it.

Logically disaster threatens the breech baby because the balanced pressures which safeguard the medulla in normal labor are likely to be upset. Pathologically the evidence is clear that injury to the medulla or to the upper cord kills most of the babies who perish. The vigorous use of measures designed to save the child from death by suffocation increases the already great risk of death from injury.

CONCLUSIONS

In this paper the results of the imposition of force upon the fetus during delivery are considered from a neurological and physiological point of view.

The most important lesions, directly referable to force, are: (1) rupture of the falx or the tentorium, and (2) rupture of the cervical spinal column. These lesions are not in themselves fatal, but they expose the medulla and the upper cord to injury.

Under ordinary conditions the medulla is guarded from harmful pressure by the tentorium, which modifies and controls force imposed upon the vertex, and by equilibrium of fluid pressure at the foramen magnum, which prevents downward dislocation of the contents of the posterior fossa. This balance of pressure can be upset and herniation of the cerebellum and medulla produced by rupture of the dural septa or by combinations of forces which maintain or increase intracranial pressure while diminishing spinal pressure.

Breech extraction, as usually performed, brings dangerous and unphysiological forces into play. Pathological evidence shows that

rupture of the tentorium occurs in 88 per cent of the still-births following so-called normal breech labors. In addition a considerable number of injuries of the vertebral column or of the spinal cord can be logically attributed to traction during breech deliveries.

Aside from the gross injuries, which account for about half of the death rate in viable newborn babies, various alterations in pressure during delivery and certain manœuvres during resuscitation may produce fatal or disabling lesions within the central nervous system.

Asphyxia, as commonly described in obstetrical literature, is vaguely defined. Pathological and experimental evidence of its existence is not available. While the absence of proof is not in itself evidence against the obstetrical conception, it invites challenge. The pathological findings, particularly those in babies dying after breech delivery, raise the question whether efforts to avoid fetal asphyxia may not add to the already great risk of injury to the contents of the craniovertebral cavity.

BIBLIOGRAPHY

ANATOMICAL AND PATHOLOGICAL EVIDENCE

A. General Review

1. Ehrenfest, H. Birth Injuries of Child. New York: 1922.

B. Cranial Cavity

2. Beneke, R. Ueber Tentoriumzerreissungen bei der Geburt. Muenchen. med. Wchnschr., 1910, lvii, 2125.
3. Holland, E. On cranial stress in the fetus during labour, etc.; with an analysis of 81 cases of torn tentorium, etc. Obst. Tr., Edinburgh, 1920, xl, 112.
4. Meyer, L., and Hauch, E. Les ruptures de la dure-mère cranienne chez les nouveau-nés. Arch. mens. d'obst. et de gynéc., 1912, i, 246.
5. Pott, R. Ueber Tentoriumzerreissungen bei der Geburtsh. Ztschr. f. Geburtsh. u. Gynaek., 1911, lix, 674.
6. Schwartz, P. Die Ansaugungsblutungen im Gehirn Neugeborener. Ztschr. f. Kinderh., 1921, xxix, 102.
7. Idem. Die traumatische Geburtsschaedigung des Gehirns. Muenchen. med. Wchnschr., 1922, xlix, 1110.
8. Vischer, A. L. Ueber Tentoriumrisse der Neugeborenen. Abstracted Zentralbl. f. Gynaek., 1919, xliii, 851.
9. Ylppö, A. Pathologisch-anatomische Studien bei Fruehgeborenen. Ztschr. f. Kinderh., 1919, xx, 212.
10. Zangemeister, W. Ueber Tentoriumrisse. Zentralbl. f. Gynaek., 1921, xlv, 457.

C. Spinal Cord

11. Ruge, C. Ueber die Verletzungen des Kindes durch die Extraction, etc. Ztschr. f. Geburtsh. u. Frauenkrankh., 1875, i, 69.
12. Stoltzenberg, F. Zerreissungen der intervertebralen Gelenkkapseln der Halswirbelsaeule, eine typische Geburtsverletzung. Berl. klin. Wchnschr., 1911, xlviii, 1741.

PHYSIOLOGICAL EVIDENCE

13. Cannon, W. B., and Burket, I. R. Endurance of anæmia by nerve cells in myenteric plexus. Am. J. Physiol., 1913, xxxii, 347.
14. Crile, G. W., and Dolly, D. H. An experimental research into the resuscitation of dogs killed by anæsthetics and asphyxia. J. Exp. Med., 1906, viii, 713.
15. Cushing, H. Physiologische und anatomische Beobachtungen ueber den Einfluss von Hirnkompression auf intracraniellen Kreislauf. Mittl. a. d. Grenzgeb. d. Med. u. Chir., 1902, ix, 773.
16. Dandy, W. E., and Blackfan, K. D. Internal Hydrocephalus. Am. J. Dis. Child., 1914, viii, 406, and 1917, xiv, 424.
17. Dandy, W. E., Experimental hydrocephalus. Ann. Surg., 1919, lxx, 129.
18. Eyster, J. A. E. Clinical and experimental observations upon Cheyne-Stokes respiration. J. Exp. Med., 1906, viii, 565.
19. Gomez, L., and Pike, F. H. Histological changes in nerve cells due to temporary complete anæmia of the central nervous system. J. Exp. Med., 1909, xi, 257.
20. Hill, L. Physiology and Pathology of Cerebral Circulation. London: 1896.
21. Stewart, G. N., Guthrie, C. C., Burns, R. L., and Pike, F. H. The resuscitation of the central nervous system of mammals. J. Exp. Med., 1906, viii, 289.
22. Weed, L. H. Cerebrospinal fluid. Physiol. Rev., 1922, ii, 171.
23. Wolbach, S. B. Multiple hernias of the cerebrum and cerebellum due to intracranial pressure. J. M. Research, 1908, xix, 153.

CLINICAL EVIDENCE

24. Beach, H. H. A., and Cobb, F. Traumatic asphyxia. Ann. Surg., 1904, xxxix, 481.
25. Crothers, B. Injury of spinal cord in breech extraction, etc. as an important cause of fetal death and paraplegia in childhood. Am. J. M. Sc., 1923, clxv, 94.
26. Edgar, J. C. Practice of Obstetrics. Philadelphia: 1916.
27. Green, T. M. Traumatic asphyxia. Surg., Gynec. & Obst., 1922, xxxv, 129.
28. Little, W. J. On the influence of abnormal parturition, difficult labours, premature births and asphyxia neonatorum on the mental and physical condition of the child. Obst. Tr., Lond., 1861, iii, 293.
29. Munro, D., and Eustis, R. S. Intracranial hæmorrhage in newborn. Am. J. Dis. Child, 1922, xxiv, 273.
30. Williams, J. W. Obstetrics. New York: 1917.

SPINAL AND CRANIAL INJURIES OF THE BABY IN BREECH DELIVERIES

A Clinical and Pathological Study of Thirty-Eight Cases[1]

By RICHARD N. PIERSON, M.D., New York
Assistant Attending Obstetrician and Gynecologist, The Sloane Hospital for Women

THE purpose of this paper is to add to the accumulating evidence showing that natal or neonatal death in breech deliveries is more often due to the injury and shock from unphysiological extraction, than to asphyxia of the baby caused by interference with placental or umbilical cord circulation.

In estimating the fetal mortality of breech deliveries, textbooks vary from 5 to 30 per cent. However, estimates based on large series of cases are infrequent in the literature. The fetal mortality in viable babies, in primary breech deliveries in the first 20,000 cases at the Sloane Hospital for Women, has been found by Ryder to be 8 per cent. A series of 5,000 deliveries beginning in 1915 showed a mortality of 12 per cent. It is agreed, therefore, that a fetal mortality of from 10 to 15 per cent in such deliveries is conservative.

Why should there be such a high mortality in breech deliveries? Asphyxia is emphasized as the cause of death in nearly every textbook on obstetrics. By asphyxia is meant a general asphyxia of the baby caused by interference with placental or umbilical cord circulation. It is said to express itself at birth as "asphyxia livida" in the less severe cases, and as "asphyxia pallida" in the more severe ones. Its mechanism is described as compression of the umbilical cord between the pelvis of the mother and the aftercoming head of the baby or as premature separation of the placenta. Most authorities suggest that the compression of the cord is complete while the head is passing through the pelvis and that, clinically, a period of complete asphyxia must be considered to exist between the birth of the navel and the mouth. A tradition is expressed in the literature, and exists in most obstetrical clinics, to the effect that this asphyxia cannot be tolerated by the baby for more than from 5 to 8 minutes. In other words, extraction from navel to mouth must be effected in less than 8 minutes or the baby will be lost. Acting on this tradition, it is the custom in many obstetrical clinics, during a breech delivery, to have an attendant call out the half minutes so that the operator may thereby be stimulated to more and more heroic efforts as the lethal moment, established by the time tradition for that particular clinic, approaches. That the importance of asphyxia as a cause of death in breech deliveries has been exaggerated with the resulting development of unsound philosophy and practice, is shown by a convincing literature that finds almost no reflection in textbooks on obstetrics, or in routine clinical practice. This evidence is found to arise from clinical, pathological, and physiological observations.

LITERATURE

A. Experimental and pathological evidence of injuries from breech delivery in the newborn. In 1874, Duncan (6) performed experiments on the tensile strength of a fresh adult fetus. He found that the vertebral column yielded with traction of 105 pounds, and that decapitation occurred with 120 pounds. He found that the cervical vertebræ invariably gave way, that one leg was stronger than the neck, and that the soft parts resisted longer than the skeleton.

In 1875, Ruge (18) reported 8 cases of ruptured cervical spine in a series of 64 dead babies delivered by the breech. He noted that obstetrical vertebral fractures consist in the detachment of the epiphyses along the normal demarcation line.

In 1892, Spencer (19) reported a series of 130 autopsies on fresh, mostly stillborn, fetuses in a study of visceral hæmorrhages. He found hæmorrhage somewhere within the spinal canal in 30 cases. He concluded that spinal hæmorrhage was greatly favored by presentation of the lower extremity.

[1] From the Department of Obstetrics and Gynecology under the direction of Professor William E. Studdiford, and from the Department of Pathology under the direction of Associate Professor W. C. Johnson, College of Physicians and Surgeons, Columbia University.

In 1907, Hofbauer (9) reported the cervical spine most often injured, and the sixth cervical vertebra most frequently fractured in breech deliveries.

Stoltzenberg's (20) classic description of vertebral birth injuries appeared in 1911. It was abstracted by Kooy as follows: "She found 9 vertebral fractures in 75 autopsies on babies dead from 'Asphyxia.' Eight of these were in breech deliveries. The mechanism of the rupture was the following: First of all, the lateral capsule ligaments were torn, then followed the adjacent part of the ligaments of the neural arch (which are very tender in the newborn); finally, the cartilaginous part of the vertebræ themselves. The author confirmed this conception by experiments on extraction of the bodies of newborn children with a traction of a certain power. She obtained the same kind of rupture, the extent of which was proportional to the degree of deviation from the longitudinal axis in a lateral direction to the power of traction. It was evident that especially cases of the aftercoming head with difficult development of the arms and shoulders caused the spinal lesion in question, for in these cases, traction at the column is combined with deviation from the longitudinal axis, and it is also easily understood that it is especially the cervical column that is most apt to rupture for the angle between the axis of traction and the child's longitudinal axis is situated there."

In 1912, Meyer and Hauch (7) found ruptures of the cranial dura in 11, or 23 per cent, of 47 breech delivery deaths. Five of these were thought to have caused the death of the baby.

Von Reuss (17), in 1914, gave a masterly account of birth injuries to the skull, vertebral column, and central nervous system. He reviewed the literature to date. Some of his observations were as follows: "The hæmorrhages affecting the central nervous system, which are important in the pathology of the newborn, are almost entirely of traumatic origin. The rupture of vessels which give rise to hæmorrhage are, so far as they concern larger vessels, the direct consequence of birth injuries. Smaller extravasations of blood owe their origin chiefly to congestion caused by labor and, therefore, are indirectly attributable to action of forces during the birth process. Congestion, for its part, exercises considerable influence on the intensity of hæmorrhage caused by direct trauma, so the clinical differentiation between traumatic and congestive hæmorrhage is not possible." In speaking of injuries within the spinal canal, von Reuss said: "Birth trauma is the most important etiological factor for hæmorrhage in the spinal canal, just as it is for cerebral hæmorrhage; hæmorrhages within the vertebral canal and within the canal itself occur practically entirely after forcible extraction from a breech presentation. They may or may not be combined with injuries of the vertebral column. Ruptures within the region of the vertebral column which occur chiefly in the cervical region, almost always cause death a short time after birth, as they lead to intraspinal extravasation of blood into the vertebral canal which compresses not only the cervical portion of the cord, but may also reach the medulla oblongata and posterior fossa of the skull. Extraction of the child may, however, cause rupture of the vessels, extravasation of blood in the cord and its membranes without there being injury of the vertebral column."

Warwick (21), in 1921, found 3 cases of fractured cervical vertebræ occurring in version and breech deliveries in a series of 130 autopsies.

Brown (2), in 1922, reported 153 autopsies on the newborn with special reference to the cause of death. In concluding he said in part: "If we take 3 per cent as the normal frequency of breech deliveries, it is found that the latter is ten times as likely to give rise to cerebral hæmorrhage as is delivery by the vertex." He also noted that hæmorrhage in the adrenals was twenty-two times more common in breech than in vertex deliveries.

Capon (4), in 1922, in a series of 80 neonatal deaths and stillbirths studied at autopsy, found that 4 out of the 10 breech babies in the series showed spinal injury; 3 of them showed separation of the epiphyses from the body of the sixth and seventh cervical and third thoracic vertebræ, respectively.

TABLE I.—BREACH DELIVERIES RESULTING IN DEATH OF A VIABLE BABY AUTOPSY SHOWING ONE OR MORE FRACTURED VERTEBRÆ

History No. Series No.	Age Race Para	Important obstetrical conditions and procedures	Important autopsy findings	Clinical notes A. Cervix D. Cord. B. Arms E. Anæsthesia. C. Head F. Time of delivery.
44742 1	20 Black 1 normal full term delivery	Breech presentation Stillbirth	Weight 4500 gms. Length 53 cms. Head 35.5 cms. Transverse fracture of sixth cervical vertebra. Complete laceration of spinal cord. Moderate fluid hæmorrhage at base of brain	In the breech extraction both arms became extended and were delivered with difficulty posteriorly. Time of delivery from navel to mouth 3¼ minutes. Total time of delivery 10 minutes. Cause of death: trauma.
1853 2	25 Italian Para-O	Dry labor Frank breech Stillbirth	Weight 3700 gms. Length 44 cms. Transverse fracture sixth cervical vertebra. Brain is congested and shows diffuse hæmorrhage and œdema	Frank breech presented at vulva. Feet were then brought down. No further details save that there was difficulty in the delivery of the head. Cause of death: trauma.
2188 3	24 Jewess Para-O	Dry labor Frank breech Asphyxia pallida Death at birth	Weight 4000 gms. Length 53 cms. Head 35.5 cms. Transverse fracture of fourth cervical vertebra. No laceration of spinal cord. Moderate extradural hæmorrhage at base	No details save that the head was delivered with difficulty. Baby's heart continued 1 hour after birth. Cause of death: trauma.
714 4	31 White 1 stillbirth Cause not stated	Frank breech Stillbirth	Weight 3500 gms. Length 53 cms. Head 35.5 cms. Marked extradural hæmorrhage in cervical region of spinal cord. Extradural hæmorrhage at base of brain. Transverse fractures of two cervical vertebræ. Marked hæmorrhage into muscles and fascia anterior to cervical vertebræ	The first arm was delivered anteriorly, the second posteriorly. No further details of the technique save that difficulty was encountered with the aftercoming head. Total time of delivery 10 minutes. Cause of death: trauma.
42844 5	26 White Para-O	Dry labor Frank breech Dilatation of cervix-bag Craniotomy Stillbirth	Weight 7 lbs. 12 ozs. Length 52 cms. Head 33 cms. Transverse fracture of sixth cervical vertebra. Fluid blood in spinal canal. Hæmorrhage in prevertebral fascia from third cervical to first dorsal vertebra	Delivery described as easy up to the head when chin became anterior and the head extended. Finally craniotomy was done. Time of delivery 17 minutes. Cause of death: trauma.
42948 6	40 Black Para-O	Male type pelvis Frank breech Asphyxia pallida Death at birth	Weight 3400 gms. Length 52.5 cms. Head 35.5 cms. Transverse fracture of sixth cervical vertebra. Moderate extradural hæmorrhage in dorsal region of cord, very little subdural hæmorrhage. Spinal cord not lacerated. Slight subdural hæmorrhage at base. Marked hæmorrhage into anterior cervical tissues, behind œsophagus to pharynx and behind parietal pleura at both apices. There is also hæmorrhage into tissues of left axilla	Cervix fully dilated. Arms became extended and were delivered posteriorly. Extraction of head not difficult. Total time of delivery 6 minutes, navel to mouth 5 minutes; baby gasped during delivery. Heart continued for ½ hour. Cause of death: trauma.
43519 7	26 Black 6 normal deliveries 1 Cæsarean	Frank breech Asphyxia pallida Death of baby	Weight 3300 gms. Length 48 cms. Head 34 cms. Transverse fracture of sixth cervical vertebra. No laceration of cord but marked extra- and subdural hæmorrhage. Considerable subdural hæmorrhage at base of brain. Clotted hæmorrhage in both hemispheres of cerebellum. Moderate laceration of cerebellar tissue. There are scattered hæmorrhages in tentorium cerebelli. Lungs showed diffuse pneumonia	Cervix fully dilated. Complete ether anæsthesia. Feet brought into vagina. Both arms delivered posteriorly. No difficulties in delivery mentioned. Time of entire delivery 5 minutes. Baby lived 3 days. Cause of death: trauma.

Eardley Holland (10), in 1922, reported an investigation into the factors which determined death in 300 viable fetuses. Concerning injuries and their causes sustained by the baby in breech deliveries, he said: "I will state at once the remarkable fact that tears of the tentorium cerebelli and cerebral hæmorrhage are almost constantly found in dead fetuses delivered by the breech; this throws a flood of light on the cause of fetal death in breech labor and indicates precisely the obstetrical faults in its management. The fact that 14 out of 16 fetuses which died as the result of breech delivery showed, postmortem, signs of excessive cranial stress is of great importance."

B. Clinical and pathological evidence in older children of birth injuries from breech deliveries. McNutt (14), in 1885, reported the autopsy findings in a child suffering from spastic paraplegia or Little's disease that died of pneumonia at 2½ years. The child had had a difficult breech delivery requiring forceps on the aftercoming head. It had had convulsions during the first 9 days of life. A splendid gross and microscopic study of the central nervous system was detailed by Amidon and Welsh. McNutt reported also a child that died on the eighth day following difficult breech delivery. At autopsy, cerebral and spinal cord hæmorrhage was found. Thus McNutt and her collaborators supplied the

TABLE II.—VERSION AND BREECH DELIVERIES RESULTING IN DEATH OF A VIABLE BABY AUTOPSY SHOWING ONE OR MORE FRACTURED VERTEBRÆ

History No. Series No.	Age Race Para	Important obstetrical conditions and procedures	Important autopsy findings	Clinical notes A. Cervix D. Cord. B. Arms E. Anæsthesia. C. Head F. Time of delivery.
43159 8	35 Black 3 normal deliveries	Placenta prævia Dilatation of cervix-bag Version and breech Stillbirth	Weight 2550 gms. Length 49 cms. Transverse fracture through body of sixth cervical vertebra at junction of cartilage between fifth and sixth vertebræ. Spinal cord lacerated and protruding through opening. Marked extra- and subdural hæmorrhage in cervical spinal cord. Moderate diffuse hæmorrhage at base of brain. Marked hæmorrhage into anterior cervical tissues	Marked difficulty was encountered in the delivery of the aftercoming head. The difficulty was attributed to incomplete dilatation of the cervix. A snap was heard while efforts were being made to deliver the head. Total time of delivery 5 minutes. Cause of death: trauma.
42711 9	27 Black Para-O	Flat pelvis Dilatation of cervix High forceps Version and breech Stillbirth	Weight 3700 gms. Length 53 cms. Transverse fracture through body of fifth cervical vertebra. No lacerations of spinal cord. Extra- and subdural hæmorrhage of cervical cord. Slight subdural hæmorrhage at base of brain. Separation of epiphyses of femur on right side	Cervix fully dilated. One leg only brought down; there was marked difficulty in bringing the half breech through the pelvis. No details of delivery of arms and head but described as not difficult. Cause of death: trauma.
42760 10	28 White 1 instrumental Died at birth	Flat pelvis Version and breech Dilatation of cervix—manual Asphyxia pallida Death at birth	Weight 3700 gms. Length 53 cms. Transverse fracture involving disc between fifth and sixth cervical vertebræ. Spinal cord lacerated. Marked subdural hæmorrhage in cervical region. Slight subdural hæmorrhage at base of brain. Marked hæmorrhage into anterior cervical tissues	Cervix dilated manually. Umbilical cord twice around neck and once around body. No difficulty described in delivery but details are lacking. Total time of delivery 4 minutes. Heart continued for several minutes and baby gasped twice. Cause of death: trauma.
45476 11	27 Black 3 normal deliveries 1 stillbirth from impacted shoulders	Dry prolonged labor Dilatation of cervix-bag Generally contracted pelvis Version and breech Asphysix pallida Death at birth	Weight 3300 gms. Length 49 cms. Cranial bones very hard. Transverse fracture of sixth cervical vertebra at junction of cartilage between fifth and sixth vertebræ. Spinal cord not lacerated. Slight diffuse hæmorrhage at base of brain. Hæmorrhage into anterior cervical tissues	Marked difficulty with delivery of shoulders. Both finally delivered posteriorly. No difficulty in delivery of head. Baby's heart continued for 20 minutes. Cause of death: trauma.
489 12	2 normal deliveries	Transverse presentation Version and breech Stillbirth	Weight 3400 gms. Length 51 cms. Transverse fracture of sixth cervical vertebra. No lacerations of cord. Slight subdural hæmorrhage in cervical region. Marked hæmorrhage into anterior cervical tissues Brain described as relatively normal	Cervix completely dilated. Both arms became extended, the posterior one was delivered first. Time from birth of navel to delivery of head was 7 minutes. Cause of death: trauma.
1394 13 See Figure 3	32 White 2 normal deliveries	Placenta prævia Dilatation of cervix-bag Version and breech Stillbirth	Weight 3500 gms. Length 36 cms. Transverse fracture of third thoracic vertebra. Laceration of spinal cord is complete. Marked hæmorrhage into tissues about site of fracture. Brain not described	Cervix incompletely dilated. Marked difficulty in delivery of head, thought to be due to cervix. Total time of delivery 5 minutes. Cause of death: trauma.
1207 14	38 Black 2 normal deliveries 1 instrumental	Old laceration of cervix. Cicatrix of cervix. Generally contracted flat pelvis Version and breech Stillbirth	Weight 3800 gms. Length 53 cms. Head 36.5 cms. Transverse fracture of sixth cervical vertebra. Marked hæmorrhage into adjacent cervical tissues. Brain shows congestion and some blood on surface of the hemispheres	Marked difficulty in delivery of aftercoming head. No details. Cause of death: trauma.

pathological evidence necessary to complete the contention of Little (13) based upon clinical observations. She showed the relationship between cerebral and spinal hæmorrhage at birth and Little's disease of later life, and noted that such hæmorrhage was particularly common as the result of breech delivery.

Beevor (1), in 1902, reported a baby born by difficult breech extraction that showed paralysis of the right arm and both legs. It died at 15 weeks. At autopsy, fracture-dislocation of the third cervical vertebra was found with complete destruction of the spinal cord below.

Kooy (11), in 1920, reported a case of Little's disease that died in its ninth year. It had been delivered by version and breech extraction. Rupture of the low thoracic spinal cord was found at autopsy. He gave in admirable detail the clinical and pathological findings of this case, as well as an excellent résumé of the literature.

Burr (3) reported, in 1920, 2 cases of flaccid paralysis following breech delivery. One child

TABLE III.—VERSION AND BREECH DELIVERIES RESULTING IN DEATH OF A VIABLE BABY

History No. Series No.	Age Race Para	Important obstetrical conditions and procedures	Important autopsy findings	Clinical notes A. Cervix D. Cord. B. Arms E. Anæsthesia. C. Head F. Time of delivery.
42870 15	White Para-O	Prolonged labor Transverse presentation Version and breech Stillbirth	Weight 2900 gms. Length 52 cms. Head 33.5 cms. Skull and brain described as relatively normal. No fracture of spine. Spinal cord not examined	Cervix 3 fingers dilated when membranes ruptured and elbow presented. Cervix then dilated manually. Delivery described as not difficult. No details of treatment of arms. Time of delivery: foot 2:58, breech 3:00, navel 3:03, shoulders 3:04, mouth and head 3:05. Cause of death: asphyxia-trauma.
43490 16	32 Black Para-O	Male pelvis funnel Dry labor Dilatation of cervix-bag High forceps Version and breech Craniotomy Stillbirth	Weight 7 lbs. 4 ozs. Length 52 cms. No autopsy	Beginning contraction ring. No progress with forceps. Marked difficulty in delivering arms and head. Craniotomy finally done because fetal heart had ceased. Cause of death: asphyxia-trauma.
43531 17	24 Black 1 instrumental Stillbirth	Prolapsed cord Version and breech Stillbirth	Weight 4200 gms. Length 54 cms. Head 35 cms. Brain described as relatively normal. No fractures of vertebræ. No laceration of cord. Moderate extradural hæmorrhage in cervical region	Pulsating prolapsed cord found with cervix fully dilated. Shoulders delivered, the first anteriorly, the second posteriorly. The head became extended and was delivered with difficulty. Time of delivery: foot 4:11, breech 4:17, navel 4:18, shoulders 4:20, mouth 4:24, head 4:25. Cause of death: asphyxia-trauma.
2087 18	39 White Para-O	Prolonged labor Uterine inertia High forceps Version and breech Craniotomy Stillbirth	Weight 3650 gms. Length 53 cms. Spine and cord severed by craniotomy	No advance with axis traction forceps. Cervix dilatable. Extraction described as easy up to head. Details of difficulty with head not described. Cord finally ceased pulsating so that craniotomy was done. Cause of death: asphyxia-trauma.
1060 19	26 White Para-O	Flat pelvis Prolapsed cord Version and breech Stillbirth	Weight 3150 gms. Length 52 cms. Brains and spine described as relatively normal	Version because of partial prolapse of cord with heart under 100. Extraction easy up to head. Difficulty with head ascribed to pelvis. Total time of extraction about 10 minutes. Cause of death: asphyxia-trauma.
43053 20	35 White Para-O	Pelvis obliquely contracted Toxæmia of pregnancy Induction of labor-bag Version and breech Asphyxia pallida Death at birth	Weight 2950 gms. Length 49 cms. Slight diffuse hæmorrhage over brain with moderate œdema of pia arachnoid. No fractures of spine.	Extraction described as difficult because of small pelvis. Difficulty with aftercoming head. Heart continued for several minutes. Cause of death: asphyxia-trauma.
45096 21	42 White 2 normal deliveries 2 instrumental deliveries	Mitral stenosis Prolapsed cord Version and breech Asphyxia pallida Death at birth	Weight 5 lbs. 11 ozs. Length 49 cms. No autopsy	Version was done and cord replaced through a cervix well thinned out but not completely dilated. Baby's feet brought into vagina, fetal heart normal. In 4 hours patient pushed thighs of baby to vulva. Extraction was begun under "light anæsthesia." Anterior arm became extended but was delivered easily. Difficulty with aftercoming head thought to be due to cervix. Baby's heart continued for one hour. Cause of death: asphyxia-trauma.
2300 22	40 White Grav.-XII Several Normal deliveries; 2 instrumental	Toxæmia of pregnancy High forceps Version and breech Stillbirth	Weight 4058 gms. Length 51.5 cms. No autopsy	High forceps attempted—no advance. Version in tonic uterus. Breech extraction described as easy up to head. Details of arms not described. Cord not pulsating when breech was delivered. Details of difficulty with head not described. Cause of death: asphyxia-trauma.
43381 23	20 White 1 full term normal	High forceps Version and breech Craniotomy Stillbirth	Weight 8 lbs. 14 ozs. Length 54 cms.	Six hour second stage—no progress. Head extended. High forceps attempted—no advance. No details of delivery save that aftercoming head could not be delivered. Craniotomy finally done. Cause of death: asphyxia-trauma.
1776 24	35 White Para-O	Male pelvis Placenta prævia Hæmorrhage High forceps Version and breech Stillbirth	Weight 9 lbs. 10 ozs. No autopsy	Delivery of the aftercoming head became difficult at the pelvic outlet. Considerable hæmorrhage intrapartum and postpartum. Cause of death: asphyxia.

TABLE III.—VERSION AND BREECH DELIVERIES RESULTING IN DEATH OF A VIABLE BABY—CONTINUED

History No. Series No.	Age Race Para	Important obstetrical conditions and procedures	Important autopsy findings	Clinical notes A. Cervix B. Arms C. Head D. Cord. E. Anæsthesia. F. Time of delivery.
711 25	30 White Para-0	Flat pelvis Toxæmia of pregnancy Medium forceps Version and breech Asphyxia pallida Death of baby	No autopsy	No advance of head with traction on forceps. Easy version and breech. No difficulties encountered. Baby had convulsions and bleeding from ear. Died on third day. Cause of death: trauma.

died at 4½ months and showed at autopsy a level of hæmorrhage to the fourth cervical vertebra with destruction of the cord to the first dorsal. The second baby died at 3 months. No autopsy was permitted.

In 1923, Crothers (5) reported 5 cases of paraplegia in childhood, the result of injury to the spinal cord in breech extraction. He gave a review of the literature and an adequate discussion of the obstetrical, pathological and physiological factors involved in the causation of such injuries.

Thus the literature affords abundant evidence of the immediate and late manifestations of the casualties of breech deliveries.

CLINICAL AND PATHOLOGICAL STUDY OF THIRTY-EIGHT CASES OF INJURY AND DEATH FROM BREECH DELIVERY

For the past 3 years, 76 per cent of all antenatal, natal, and neonatal deaths at the Sloane Hospital for Women have been studied at autopsy. It was noted that deaths in breech deliveries often occurred in large well-developed babies, and that many showed fractured vertebræ at autopsy. Many of the earlier autopsies were unsatisfactory, because an adequate routine technique was not followed, so that the occurrence of tentorial lacerations was not noted, nor were the various types of cerebral and spinal cord hæmorrhages described adequately in some cases. Latterly, through the lessons of experience and study of the literature, a complete autopsy technique has been adopted.[1]

From March, 1920, to September, 1922, in 142 viable babies in primary breech deliveries, natal and neonatal death occurred in 18, or 12 per cent. The incidence of breech presentation was 3 per cent. In 87 viable babies delivered by version and breech during the same period, natal or neonatal death occurred in 18, or 26 per cent. Version and extraction in this series was never elective, but was indicated by placenta prævia, prolapsed cord, malpresentation, or an abnormal pelvis. A clinical and pathological study of these natal or neonatal deaths is tabulated.

CLINICAL AND PATHOLOGICAL SUMMARY

1. In 142 viable primary breech deliveries, natal or neonatal death occurred in 18, or 12 per cent. The incidence of breech presentation was 3 per cent.

2. In 87 viable version and breech deliveries, natal or neonatal death occurred in 18, or 26 per cent.

3. Spinal cord hæmorrhage was noted in 17, or 47 per cent, of the 36 cases; fractured vertebræ were found in 14, or 38 per cent.

4. Intracranial hæmorrhage was present in 44 per cent. However, it was considerable in only 25 per cent.

5. Clinical difficulty with delivery of the head was noted in 57 per cent of the cases; difficulty with arms and shoulders in 25 per cent; and difficulty from an incompletely dilated cervix in 11 per cent of the cases.

[1]Autopsy technique. Mid line incision from chin to pubis passing to left of navel. All organs of neck, thorax and abdomen are examined *in situ*, removed and weighed and examined grossly and microscopically. All vertebræ are exposed anteriorly and examined for luxation and fracture. A posterior mid line incision is then made from occiput to sacrum. Starting at the sacrum, the laminæ are cut with bone forceps and the spinal dura exposed throughout its length. The complete cord is then removed inclosed in the dura and examined for hæmorrhage and injury. The scalp is then incised approximately in the line of the coronal suture and the scalp reflected anteriorly and posteriorly over the entire skull. The anterior fontanel is punctured with a knife at its lateral margin so that bone scissors may be inserted. The bone and dura are divided on both sides parallel to the longitudinal sinus, but at a safe distance from it, posteriorly as far as the lambdoid suture and anteriorly as far as possible. The flap is then continued posteriorly along the line of the lambdoid suture and squamous suture and as low as possible on the frontal and parietal bones. Before removal of the brain, the hemispheres are gently retracted and the falx and tentorium examined for tears and hæmorrhages.

TABLE IV.—BREECH DELIVERIES RESULTING IN DEATH OF A VIABLE BABY

History No. Series No.	Age Race Para	Important obstetrical conditions and procedures	Important autopsy findings	Clinical notes A. Cervix D. Cord. B. Arms E. Anæsthesia. C. Head F. Time of delivery.
45332 26	40 White 2 normal deliveries	Breech presentation Prolapsed cord Asphyxia pallida Death at birth	Weight 8 lbs. 5 ozs. Length 54 cms. No autopsy	Prolapsed cord replaced through cervix dilated to 3 fingers. Feet allowed to remain in cervix 1 hour. Fetal heart satisfactory just before delivery. No difficulties described in the delivery. Total time of delivery 4 minutes. Baby's heart continued beating slowly for 40 minutes. Cause of death: asphyxia-trauma.
42984 27	33 White Para-O	Toxæmia of pregnancy Induction of labor-bag Breech extraction Forceps on aftercoming head Occiput posterior persistent Asphyxia pallida Death at birth	Weight 4200 gms. Length 56 cms. Head 37 cms. Spine showed no fractures. Brain described as relatively normal Spinal cord not examined	Vertex presented before induction with No. 2 Bag. No. 4 Bag used next. When bag came through Frank breech was reduced by bringing down 1 leg. Delivery described as easy up to head which became occipitoposterior and could not be delivered. Forceps applied and head delivered quickly as occipitoposterior. Heart continued beating for 1 hour. Cause of death: trauma.
44670 28	White 1 instrumental delivery Baby well	Dry labor Frank breech Stillbirth	Weight 8 lbs. Length 52 cms. No autopsy	Fetal heart could not be heard when breech presented at vulva. Delivery described as easy. No details. Time of delivery 4 minutes. Cause of death: asphyxia.
438 29	37 White 3 normal deliveries	Toxæmia of pregnancy Twin pregnancy A. Vertex B. Breech Stillbirth	Weight 1950 gms. Length 29 cms. Brain described as relatively normal No vertebral fractures Spinal cord not described	Second baby presented by breech. Cord was not pulsating when navel was born. No details of delivery. Time of delivery 5 minutes. Cause of death: asphyxia trauma.
748 30	26 White Para-O	Twin pregnancy A. Breech, prolapsed cord, dilatation of cervix Asphyxia pallida Death of baby B. Vertex, version and breech	Weight 6 lbs. 6 ozs. Length 49 cms. Spine and brain described as relatively normal	Cervix dilated manually from 2 fingers to full dilatation because of prolapsed cord. Baby's heart beating at birth. No details of technique of delivery. Time of extraction 1½ minutes. Second stage of labor 50 minutes. Cause of death: asphyxia-trauma.
43806 31	40 White Para-O	Grave's disease Premature labor Dry labor Breech presentation Stillbirth	Weight 2060 gms. Length 44.5 cms. Head-occipital frontal 31.5 cms. No caput but small cephalhæmatomata over occipitals and parietals. Moderate amount of fluid blood over hemispheres and at base. Source not found. No hæmorrhage into brain or dura. Spine showed no lesions	Patient pushed buttocks to vulva so that cervix was thought to be well dilated. There was moderate difficulty with the head but it was thought that no undue traction was exerted. Time of delivery 6 minutes. Cause of death: trauma.
43895 32	White Para-O	Generally contracted pelvis Dry labor Frank breech Dilatation of cervix-bag Uterine inertia Asphyxia pallida Death at birth	Weight 3550 gms. Length 51 cms. Occipital frontal 36 cms. No fractures of spine. Moderate extra- and subdural hæmorrhage about cord at second and third cervical vertebræ. No laceration of cord. Small diffuse subdural hæmorrhages over hemispheres. Several small hæmorrhages in dura. Middle ears normal	When a No. 3 bag came through cervix the frank breech was reduced by bringing down a leg. Delivery described at every stage as difficult. First arm delivered anteriorly and the second posteriorly. Time of delivery 9½ minutes. Foot :28, breech :34, navel :35, shoulders :36, mouth :37, head :37.5. Baby's heart continued for 10 minutes. Cause of death: trauma.
43157 33	27 Black Para-O	Dry labor Dilatation of cervix-bag Breech presentation Laceration of cervix Asphyxia pallida Death at birth	Weight 3100 gms. Length 50 cms. Spine normal. Cord not described. Moderate diffuse subdural hæmorrhage about brain. Scattered small hæmorrhages in dura. Small amount of subarachnoid hæmorrhage. No hæmorrhages in brain substance	Cervix incompletely dilated and torn at delivery. Head became extended and was delivered with difficulty after hard pulling. Something was heard to snap during its delivery. Total time of delivery 9 minutes. Time from navel to mouth 3 minutes. Baby gasped a few times and heart continued for a short time. Cause of death: trauma.
43563 34	26 1 normal delivery at term	Breech presentation Craniotomy Stillbirth	Weight 9 lbs. Length 57 cms. No autopsy	Cervic fully dilated. First arm delivered anterior, second posterior. There was difficulty in the delivery of arms and head. Cord stopped pulsating so craniotomy was done. Time of delivery: foot :14, breech :20, navel :21, shoulders :30, mouth :37, head :37. Total 23 minutes. Cause of death: asphyxia-trauma.

TABLE IV.—BREECH DELIVERIES RESULTING IN DEATH OF A VIABLE BABY—CONTINUED

History No. Series No.	Age Race Para	Important obstetrical conditions and procedures	Important autopsy findings	Clinical notes A. Cervix B. Arms C. Head D. Cord E. Anæsthesia F. Time of Delivery.
43643 35	39 White Para-VIII 3 normal deliveries	Breech presentation Prolapsed cord Stillbirth	Weight 8 lbs. Length 56 cms. No autopsy	Cervix fully dilated. Knee in vagina with loop of pulsating cord. Both shoulders delivered posteriorly. Head delivered with relative ease. Time of delivery: foot :40, breech :42, navel :43, shoulders :43, mouth :45, head :45½. Total 5.5 minutes. Cause of death: asphyxia-trauma.
44021 36	24 White Para-O	Dry labor Prolonged labor Breech presentation Frank breech Asphyxia pallida Death at birth	Weight 3250 gms. Length 50 cms. Head 35½ cms. No fractures of spine but extra- and subdural hæmorrhage in the cervical region. Moderate diffuse fluid hæmorrhage over hemispheres. No hæmorrhage into brain or into ventricles. Middle ears normal	Dry prolonged labor first stage 34 hours, second stage 2½ hours. When cervix was fully dilated frank breech was reduced by bringing both feet into vagina. Head became extended and was delivered with difficulty. Baby's heart beating at birth. Cause of death: trauma.

6. Abnormality of cord or placenta was noted in 28 per cent of the 36 cases.

7. Trauma alone was the probable cause of death in 56 per cent of the 36 cases of natal or neonatal death; asphyxia alone, the probable cause in 5 per cent; trauma and asphyxia may have both been causative factors in 39 per cent.

8. Time of delivery from foot to head was noted in 17 cases; the average was 7 minutes.

Time of delivery from navel to mouth was noted in 8 cases; the average was 4 minutes.

9. A dilating bag had been placed in the cervix in 25 per cent of the cases; abnormal pelvis was noted in 35 per cent of the cases; 50 per cent of the mothers were primiparæ.

DETAILS AND DISCUSSION

Lacerations of the spinal cord. The spinal cord was completely ruptured at site of fracture in two cases (1 and 13), and partially ruptured in two more (8 and 10).

Hæmorrhages involving the spinal canal. Hæmorrhage was found in the spinal canal in 17 of the 36, or in 47 per cent. The 14 cases with fractured vertebræ showed extradural and subdural hæmorrhages in the affected region of the cord. Three additional cases (17, 32, and 36) showed moderate hæmorrhages in the cervical region of the cord.

Fractured vertebræ. Fourteen, or 38 per cent, of the 36 natal or neonatal deaths showed fractured vertebræ (1 and 14). Seven were primary breech and 7 were version and breech deliveries. One additional baby died at the age of 1 month (Case 37) with signs of severe cervical cord injury that probably was accompanied by vertebral fracture.

The typical lesion, a transverse separation of the upper epiphyseal plate (cartilage) of the sixth cervical vertebra, is exemplified by 10 of the 14 cases. The fourth and fifth cervical vertebræ were each fractured once. In one case (Case 13), the third thoracic vertebra showed a transverse fracture. Thus, 13 cases showed cervical fractures and one, a thoracic.

Of the 14 cases of vertebral fracture there were 9 dead-births (Cases 1, 2, 4, 5, 8, 9, 12, 13, 14), 4 deaths-at-birth (Cases 3, 6, 10, 11), and 1 neonatal death (Case 7) in which the baby survived for 3 days. Five of these babies survived delivery for a short period in a condition of so-called "asphyxia pallida."

The mechanism of these fractures was a posterior or lateral flexion of the spine combined with traction, or excessive flexion, or traction, alone. Clinical study of the case histories showed that all but two of the cases were complicated by extended arms, or difficult delivery of the head. Duplication of these complications on a manikin verified the mechanical etiology mentioned.

Intracranial hæmorrhage. Cerebral hæmorrhage was marked in only one case (Case 7). This brain showed a clotted hæmorrhage in both hemispheres of the cerebellum with moderate laceration of the cerebellar tissue. There was considerable fluid hæmorrhage at the base and scattered hæmorrhages into the tentorium.

Moderate cerebral hæmorrhage was present in 8 cases (Cases 1, 2, 3, 4, 8, 31, 33, 36) and slight hæmorrhages in 7 more (Cases 6, 9,

TABLE V.—VERSION AND BREECH DELIVERIES FOLLOWING WHICH THE BABY SHOWED SIGNS SUGGESTING SPINAL CORD INJURY

History No. Series No.	Age Race Para	Important obstetrical conditions and procedures	Important autopsy findings	Clinical Notes A. Cervix B. Arms C. Head D. Cord E. Anæsthesia F. Time of Delivery.
2257 37	28 Black 4 normal deliveries	Face presentation R. M. A. Version and breech Asphyxia pallida	Weight at birth 6 lbs. 1 oz. Baby died at 1 month of age. Autopsy refused. Bilateral flaccid paralysis lower limbs	Cervix fully dilated. Delivery of aftercoming head described as difficult. Cause of death: trauma.
42601 38	21 Black Para-0	Generally contracted flat pelvis Chronic cardiac valvular disease Dilatation of cervix-bag Version and breech Asphyxia pallida	Weight at birth 4 lbs. 1 oz. Length 46 cms. Left lower abdominal paralysis and hernia Child apparently well at 1 year	Delivery of arms difficult because of nuchal hitch. Left elbow dislocated. Coccyx broken before head could be delivered.

10, 11, 14, 20, 32). No intracerebral, nor intraventricular hæmorrhage was found. The hæmorrhage was diffuse, fluid, and most marked at the base of the brain. To recapitulate, marked or moderate hæmorrhage was found in 25 per cent of the cases and some hæmorrhage in 44 per cent. The comparatively few cases of important intracranial hæmorrhage is surprising in view of the other evidences of birth injuries found. Explanation of this may be that these babies did not live long enough for any considerable hæmorrhage to accumulate. Thus, of the entire 36 cases, 22 were dead-births, 13 were deaths-at-birth, and 1 a neonatal death. Moreover, the baby that lived longest, namely 3 days (Case 7), showed the largest cerebral hæmorrhage.

Of the 16 cases of intracranial hæmorrhage, 9 (Cases 3, 6, 7, 10, 11, 20, 32, 33, 36) survived delivery for a short period in a condition of so-called "asphyxia pallida."

Dead-births: Asphyxia or trauma the cause of death? The term dead-birth is used because it avoids the ambiguity of the term stillbirth, which may be used to signify (1) a baby born with active heart that never cries, (2) a baby born with heart not beating.

Of 22 dead-born babies in the 36 breech delivery deaths, trauma alone was the cause of death in 10, or 45 per cent (Cases 1, 2, 4, 5, 8, 9, 12, 13, 14, 31); asphyxia alone the probable cause in only 2, or 10 per cent (Cases 24 and 28); and asphyxia and trauma the possibly concomitant causes in 10, or 45 per cent, of the cases (Cases 15, 17, 18, 19, 22, 23, 29, 34, 35). In 5 of these cases, craniotomy was done; they are listed under death from asphyxia trauma, because, theoretically, some of these babies may have died from asphyxia before craniotomy. Study of these cases (Cases 5, 16, 18, 23, 34) shows, however, that marked obstetrical difficulties arose, due, presumably, to antecedent errors of judgment or art. Having found trauma unexpectedly present in many cases, when no obstetrical difficulties were noted, it seems logical to consider trauma, in general, a more important factor for fetal death than asphyxia in cases requiring craniotomy.

Death-at-birth: Asphyxia or trauma the cause of death? Death at birth is the term applied to babies that fail to maintain respiration. They usually die within an hour. Of this group of 13 (Cases 3, 6, 7, 10, 11, 20, 21, 26, 27, 30, 32, 33, 36), all showed asphyxia pallida, yet clinical and pathological study revealed trauma alone the probable cause of death in 9. Trauma and asphyxia were possibly concomitant causes in 4; whereas, in not a single case was there strong evidence that asphyxia alone was the cause of death. Moreover, 8 of these babies showed intracranial and intraspinal hæmorrhage, and 5 of the 8 had broken necks. Of the remaining 5, autopsy was refused in two.

Neonatal deaths and deaths in infancy: Asphyxia or trauma the cause of death? Case 7 survived difficult delivery for 3 days with a broken neck and large intraspinal, intra-

Fig. 1. The typical lesion—separation of the upper epiphyseal plate of the sixth cervical vertebra with intraspinal hæmorrhage.

Fig. 2. Tear in tentorium in baby delivered by breech. This baby had also intracranial hæmorrhage, intraspinal hæmorrhage, and a broken neck.

cranial, and cerebellar hæmorrhage in a condition of so-called "asphyxia pallida." Trauma and severe birth injury were obviously the cause of death. Case 37 survived difficult delivery for 1 month, having shown clinically so-called "asphyxia pallida" for a considerable period after birth, and after that a bilateral flaccid paralysis of the lower limbs. Trauma and birth injury were obviously the cause of disability and death in this case.

Clinical and pathological study of the dead births, deaths at birth, and neonatal deaths, resulting from breech deliveries, showed that trauma was more important in the causation of fetal death than asphyxia.

Placental and umbilical cord abnormalities. There were 3 cases of placenta prævia (Cases 8, 13, 24). It is evident that in partial or complete placenta prævia, and premature separation of the placenta, from any cause, there is great danger of fetal asphyxia. This was illustrated in Case 24. However, in the other 2 cases of placenta prævia, the babies showed fractured vertebræ, caused by difficulty in delivery of the aftercoming head; a difficulty attributed, in each case, to an incompletely dilated cervix. The delivery of each of these cases required only 5 minutes.

Prolapsed cord occurred in 6 of the 36 cases (Cases 17, 19, 21, 26, 30, 35). The cord was around the neck in one (Case 10). Yet fetal deaths from asphyxia alone could not be attributed to cord complications in a single instance, for in every case the clinical history showed that: (1) the cord was pulsating at the time of delivery; (2) the baby's heart was beating at birth. Moreover, 3 of the cases (Cases 17, 19, 21) were complicated by marked difficulty in the delivery of the head, so that it is probable that trauma was a factor in their death. The remaining 3 cases were delivered easily but rapidly, and were alive at birth, so that trauma and asphyxia must both be considered operative. In this connection, it should be noted that Potter (16) has learned from experience that a prolapsed cord, not pulsating, does not necessarily imply fetal death, or even dangerous fetal asphyxia and he, therefore, does not hurry delivery because of that complication.

An important cord complication, namely, cord around neck or body of baby, is described only once in the present series (Case 10). This baby showed "asphyxia pallida," but autopsy disclosed intracranial hæmorrhage, spinal cord laceration, and fractured vertebra.

Clinicians agree in fearing this complication as a possible cause both of asphyxia and injury, in every type of delivery. La Fetra (12) has reported a series of cases in which this complication was attended with a high percentage of cerebral hæmorrhage. When the cord is tightly around the neck, it is clear that the baby is subjected to: (1) danger of asphyxia; (2) danger of marked venous congestion of the brain, a predisposing and contributing cause of intracranial hæmorrhage, the exciting cause of which is trauma.

Placental and umbilical cord abnormalities must be considered possible causes of fetal asphyxia. Yet only 1 of 10 cases verified the possibility. In the remaining cases, the placenta and cord complications seemed to have incited the operator to unusual speed and violence with resulting fatal injuries to the babies. To paraphrase Holland: "Though some babies be killed by asphyxia, it seems a pity to kill them twice!"

Chief clinical difficulties in breech deliveries. Difficulty in the delivery of the aftercoming head was described in 57 per cent of the cases, difficulties with arms and shoulders in 25 per cent, and difficulty from an incompletely dilated cervix in 11 per cent.

Two errors of obstetrical judgment stand out as predisposing to these difficulties: (1) A hurried conduct of labor and delivery. It is well known that a hurried labor and delivery are prone to be complicated by an incompletely dilated cervix, extended arms, and an extended head. The time element in breech deliveries will be discussed more fully below. (2) Misjudgment of the pelvis. A contracted pelvis is prone to cause extension of arms and head in addition to offering more obstruction to the diameters of the passenger. An abnormal pelvis was noted in 50 per cent of the version and breech deliveries, and in 6 per cent of the primary breech deliveries, making a total of 35 per cent in the combined series of 36.

The outstanding errors of technique in extraction are likewise two, and are predisposed to by the tradition of necessary haste: (1) failure to accommodate in delivery the long axis of the child to the axes of the pelvis, thus causing dangerous angulations; (2) failure to accommodate the longest diameters of body, shoulders, and head to the longest diameters of the pelvis, thus causing the necessity of a dangerous degree of suprapubic pressure and traction.

Asphyxia pallida. This term has been traditionally applied to babies which at birth are white, limp, have slow feeble heart action and make little or no attempt at respiration. In the series of 38 breech deliveries, 16 babies showed this condition; 11 of the 16, or 68 per cent, showed evidence of severe birth trauma, but none of asphyxia. In the remaining 5 cases, there were some clinical and pathological evidences of asphyxia, but there were also evidences of concomitant trauma.

The foregoing evidence suggests that many, if not most, of the babies born in a condition of so-called "asphyxia pallida" in breech deliveries are rather in a condition of fetal collapse and shock, the result of injury. Ehrenfest (7) expresses a similar opinion as follows: "The majority of the actual cases of fatal traumatism still are included in the figures assigned to prematurity, congenital debility, *and most of all to asphyxia.*"

"Not only many of the intracranial, but also most of the fatal injuries of the vertebral column, spinal cord, or abdominal viscera, can be discovered only at autopsy—an autopsy, as must be emphasized, in which the skull is opened in a specific manner and the routine examination includes the vertebral column, the spinal cord, and such abdominal organs as the suprarenal bodies.

"Without an autopsy, the cause of death so often is incorrectly ascribed to asphyxia, because the majority of seriously traumatized infants exhibit a clinical picture which closely resembles that generally considered as typical for deep asphyxiation."

Death from asphyxia can occur only when the baby's blood contains a sufficient amount of carbon dioxide for a sufficient length of time. In breech deliveries, this may be caused by placental or umbilical cord abnormalties, or from asphyxia of the mother. The important placental abnormalties are: (1) placenta prævia; (2) premature separation of placenta. The important cord abnormalities are: (1) prolapse; (2) cord about neck or

Fig. 3. Fracture of third thoracic vertebra. Complete laceration of spinal cord, version and breech delivery. Case. 13.

Fig. 4. Intranatal death in breech delivery with fracture of cervical vertebra and marked extradural hæmorrhage about the spinal cord.

body of baby; (3) prolonged compression of umbilical cord by the body or head of the baby during delivery; (4) knots of cord, rupture of cord, etc.

Halliburton (8) has described the typical findings in death from asphyxia as follows: "After death from asphyxia it is found, in the great majority of cases, that the right side of the heart, the pulmonary arteries, and the systemic veins are gorged with dark blood; and the left side of the heart, the pulmonary veins and the arteries are empty."

In addition, one frequently finds evidence of attempted respiration. These evidences are chiefly the presence of blood-tinged mucus and liquor amnii in trachea and bronchi. There may also be petechial epicardial, and epipleural hæmorrhages.

The following postulates must be met before the diagnosis of fetal death from asphyxia is made: (1) that strong evidence be present of one or more of the abnormalities in the mother, baby, or delivery, causative of fetal asphyxia; (2) that autopsy performed according to certain standards of technique show evidences of asphyxia and none of important birth injury, or other adequate cause of death.

Time element in breech deliveries. In the series of breech deaths, the average time of delivery from foot to head in 17 of 36 cases was 6 minutes. The average time of delivery from navel to mouth in 8 cases was 4 minutes. These figures are below the traditional time limits imposed by fear of asphyxia, yet these babies were lost, many of them with the conventional diagnosis of "asphyxia pallida"; whereas, as has been pointed out, they were actually killed by trauma in delivery. In other words, frantic haste as opposed to deliberate skill has been the clinical error involved.

A similar conclusion has been reached by Ehrenfest (7) in the following words: "Fear of compression of the umbilical cord too often prompts the obstetrician to hurry unnecessarily with the extraction of the aftercoming head. He should remember that in the management of a breech labor, neglect to perform the various manipulations gently and precisely, implies greater danger to the child than mere asphyxiation."

Potter (16) and others have proved that 15 to 20 minutes may be allowed to pass from birth of navel to the mouth. Thus Potter has written: "I never hasten delivery after the umbilicus comes into view because experience has taught me that haste is unnecessary; that severe complication such as extension of the arms and of the head are very apt to take place when we interfere with the natural forcing powers at this particular stage of delivery.

"Experience has taught me that nearly all of the babies begin to breathe spontaneously when let alone, provided the heart is beating."

In a personal communication Dr. Potter wrote: "I place no limit upon the time allowed to pass from the birth of the navel until the child is delivered, in breech deliveries, or in extraction following version. I am governed entirely by the condition of mother and child. Today, I took 12 minutes with no injuries to the child, a loop of cord being exposed the entire time—*not pulsating*. Frequently, 8, 10, or 15 minutes is required, the longest time being 23 minutes with no injury to the child. I cannot help but feel that great damage to both mother and child was done by the hasty manner which you and I were taught to employ."

Holland (10), likewise, has indicated that the old tradition of imperative haste in breech delivery, and the tradition that asphyxia was the usual cause of death, was responsible, in large part, for the injuries found. He concluded in part as follows: "The death rate of breech fetuses will fall when it is realized that they are killed, not by cord compression, but by excessive cranial stress, and when this knowledge has brought about a corresponding change in our present obstetrical procedures. A new rule must be adopted for breech delivery. Instead of using forceful haste, we must be deliberate and deliver gently and gradually the aftercoming head."

The foregoing evidence shows sufficiently that the traditional estimate of the margin of safety in time during breech deliveries, has been greatly underestimated. It is probable that umbilical cord compression is seldom complete during breech deliveries. It is probable also that the unborn baby which has never breathed is more resistant to asphyxia than is an adult animal.

CONCLUSIONS

1. Birth injury and shock in breech deliveries cause greater fetal mortality and morbidity than asphyxia.

2. Unnecessary haste in breech extractions, prompted by fear of fetal asphyxia, often causes obstetrical complications leading to birth injuries.

3. The diagnosis of death from asphyxia in breech deliveries is only justified when (a) there is strong clinical evidence of asphyxia, but none of injury; and, (b) when complete autopsy shows characteristic signs of asphyxia, but none of injury.

4. The incidence of breech extraction may be diminished by (a) the practice of external version when possible; (b) and by stricter limitation of the indications for version and breech extraction.

5. The high mortality and morbidity of breech deliveries may also be reduced by:

a. A management of labor and delivery that will effect full dilatation of the soft parts.

b. Accommodating, in delivery, the long axis of the child to the axes of the pelvis, thus avoiding dangerous angulations. And by accommodating the longest diameters of the body, shoulders, and head to the longest diameters of the pelvis, thus avoiding a dangerous degree of traction and suprapubic pressure.

NOTE.—This article and that by Bronson Crothers, M.D., on "Changes of Pressure Inside the Fetal Craniovertebral Cavity," p. 790, are a part of a symposium read before the New York Academy of Medicine, Sections of Obstetrics and Pediatrics, March 9, 1923, which included also the article by George Hope Ryder, M.D., on "Breech Presentations Treated by Prophylactic External Version; Report of Fifty-Nine Breech Presentations so Treated," published in the November, 1923, issue, p. 660.

BIBLIOGRAPHY

1. BEEVOR, C. E. A case of congenital spinal muscular atrophy and a case of hemorrhage into the spinal cord at birth giving similar symptoms. Brain, 1902, xxv, 85.

2. BROWNE, FRANCIS J. Neonatal death. Brit. M. J., 1922, ii, 590-593.

3. Burr, Charles W. Hemorrhage into the spinal cord at birth. Am. J. Dis. Child., 1920, xix, 473.
4. Capon, Norman B. Intracranial traumata in the newborn. J. Obst. & Gynæc., Brit. Emp., 1922, xxix, 572.
5. Crothers, Bronson. Injury of the spinal cord in breech extraction as an important cause of fetal death and of paraplegia in childhood. Am. J. M., Sc., 1923, clxv, 94.
6. Duncan, J. Mathers. Laboratory note on the tensile strength of the fresh adult fetus. Brit. M. J., 1874, p. 763.
7. Ehrenfest, Hugo. Birth Injuries of the Child. New York: Appleton, 1922.
8. Halliburton. Handbook of Physiology. Philadelphia: Blakiston, 1919.
9. Hofbauer. Reference by Ehrenfest; Zentralbl. f. Gynaek., 1907, xxxi, 354.
10. Holland, Eardley. On cranial stress in the fetus during labour and on the effects of excessive stress on the intracranial contents; with an analysis of 81 cases of torn tentorium cerebelli and subdural cerebral hemorrhage. Obst. Tr., Edinburgh, 1919-1920, xl, 112, 143. The Causation of Fetal Death. London: H. M. Stationery Office, 1922.
11. Kooy, F.H. Rupture of the spinal cord in dystocia. J. Nervous & Mental Dis., 1920, lii, 1.
12. LaFetra, L.E. A case of cerebral hæmorrhage with operation. Am. J. Obst., 1909, lx, 340.
13. Little, W. J. On the influence of abnormal parturition, difficult labours, premature birth, and asphyxia neonatorum on the mental and physical condition of the child especially in relation to deformities. Tr. Obst. Soc. Lond., 1861, iii, 293.
14. McNutt, Sarah Jane. Apoplexia neonatorum. Am. J. Obst., 1885, xviii. Double infantile spastic hemiplegia with the report of a case. Am. J. M. Sc., 1885, Jan.
15. Meyer, Leopold and Hauch, E. Les ruptures de la dure-mère cranienne chez les nouveau-nés. Arch. men. d'obst., 1912, i, 246.
16. Potter, I. W. The Place of Version in Obstetrics. St. Louis: C. V. Mosby Co., 1922.
17. Reuss, August R. von. Diseases of the Newborn. New York: Wm. Wood & Co., 1921, 207, 218.
18. Ruge, Carl. Ueber die Verietzungen des Kindes durch die Extraction, etc. Ztschr. f. Geburtsh. u. Frauenkrankh., 1875, i, 69. Reference by Ehrenfest.
19. Spencer, H. B. Tr. Obst. Soc., Lond., 1892, xxxiii, 203.
20. Stoltzenberg. Zerreissungen die intervertebralen Gelenkkapseln der Halswirbelsaule, eine typische Geburtsverletzung. Reference by Kooy; Berl. klin. Wchnshr., 1911, xxxix, 1741.
21. Warwick, M. Necropsy findings in newborn infants. Am. J. Dis. Child., 1921, xxi, 488.

DEPARTMENT OF TECHNIQUE

REGIONAL ANÆSTHESIA IN GYNECOLOGY AND OBSTETRICS[1]

By WILLIAM R. MEEKER, M.D., Rochester, Minnesota
Section on Anæsthesia, Mayo Clinic
AND
BARNET E. BONAR, M.D., Salt Lake City, Utah
Former Resident Obstetrician, Cook County Hospital, Chicago

THE last few years have shown a steadily increasing interest in anæsthesia in the entire field of surgery. New methods of administering general anæsthetics have been developed and the dangers considerably lessened. The evolution has also been marked by the development of new anæsthetic drugs, of various combinations and sequences. These have served to make the period of induction more pleasant, increased the efficiency of the course of anæsthesia, and have eliminated many of the unpleasant and dangerous after-effects during the period of recovery. The improvement in methods of local anæsthesia has been no less marked, and its field of usefulness has greatly increased. Continued efforts to broaden the field of operative work which may properly be performed under local anæsthesia have gradually evolved the newer methods of field block and nerve block technique, and have tended to establish the entire system on a scientific basis. The domain of operative achievement under local anæsthesia has grown to such an extent that it is difficult definitely to limit its practicability when it is in the hands of a surgeon skilled in its use.

Since the possibility of spinal anæsthesia with cocaine was first suggested by Corning, there have been periods of enthusiastic trial and complete disuse of the method. Owing largely to the work of continental surgeons, notably Bier and Tuffier, the method was first generally introduced, and followed by a wave of enthusiasm. Like all other radical innovations, it was followed by a period of depression, when accumulated statistics demonstrated that the method could not compare in safety with the methods of general anæsthesia. The popularity of the method was revived when the less toxic drugs, stovaine and tropococaine, were introduced. Stovaine has been perhaps most widely used, but has proved unreliable probably because of its irritating qualities, and is now less used than formerly. Tropococaine is less a local irritant than stovaine, and proved more satisfactory in the days when it was readily obtainable.

Within the last few years the results from spinal anæsthesia have improved, and clinical experience with the method vastly widened. The improvement has been due, in part, to the employment of the least toxic and irritating local anæsthetic drugs, novocain and apothesine, in the subarachnoidal injection. Novocain has, on the whole, enjoyed the greatest popularity. Its toxicity is slight and it has good anæsthetic properties. The properties of apothesine are essentially similar to those of novocain; the anæsthetic qualities are as good and the toxicity is very slight. These drugs, when dissolved in the patient's own spinal fluid, slowly injected in part, with aspiration and reinjection three or four times to mix the solution more thoroughly with the fluid within the spinal canal, probably constitute the safest of the many present day methods of spinal anæsthesia.

In spite of the improvement in the drugs and technique of spinal anæsthesia, its employment has not become widespread. Its legitimate use has perhaps been greatly retarded by the carelessness and ignorance of many who have attempted to use it, as well as by the prejudice of those who have had no experience with the method. Exaggerated reports of the innocuousness of the method and attempts to make it the universal anæsthetic have served only to discredit the procedure, where its use might otherwise be valuable. Such statements for example as "absolutely safe," "without mishap," "anæsthetic of choice," and so forth, are applied to spinal anæsthesia in the same publications which also detail methods of resuscitation in cases of collapse. Even those who use it most insist that one must be prepared to meet emergencies. Al-

[1] Read by invitation, before the Chicago Gynecological Society, April 20, 1923.

though beneficial, the method may be followed by sudden danger. In the course of an otherwise successful surgical procedure the vasomotor apparatus may give way. The resulting fall in blood pressure is rapid and sometimes extreme. The patient is pale, sweating, and distressed. Whether or not this condition is collapse from shock, the picture is very similar, and while these symptoms usually pass away in the course of a comparatively short time, their presence is very disquieting. It is impossible to predict in which cases such symptoms are liable to occur.

Clinical experience has shown spinal anæsthesia to be more dangerous at the higher levels of the spine, so that the present tendency is to limit its use to operations below the umbilicus. It still maintains its place in pelvic surgery, and its use in genito-urinary surgery in males has become more widespread, while a few operators employ it in all cases possible. The indications for its use are therefore quite indefinite. While undoubtedly much progress has been made in the technique and the results obtained, the mortality is still too high to recommend it as a method of choice. It has been the custom to limit its use to those operations in which, for certain reasons, general anæsthesia is contra-indicated, and even then Braun maintains that it should be confined to operations in connection with the lower segments of the spine, and should never be used in operations as high as those on the stomach.

LOCAL ANÆSTHESIA IN GYNECOLOGY

The field of gynecology should thus offer a comparatively safe location for the use of spinal anæsthesia, in the presence of contra-indications to general narcosis. Before electing to use spinal anæsthesia, however, the question of the possibility of employing local anæsthesia must first be decided. As spinal anæsthesia is admittedly less benign than local or regional anæsthesia, it should not be employed in those operations in which the latter methods will suffice. Taking into consideration the fact that field block and sacral nerve block procedures have greatly broadened the limits of gynecological operative work which may properly be performed under local anæsthesia, the indications for spinal anæsthesia should be correspondingly restricted.

Mental ease and physical comfort. Equally important as the technique of local anæsthesia is the mental ease and physical comfort of the patient. Women, as a rule, are more apprehensive and more easily frightened than men. This condition is notably worse in women who have been

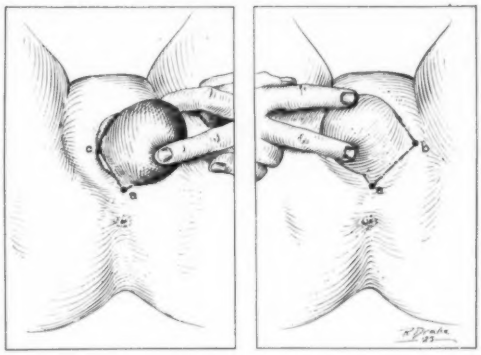


Fig. 1. Circular field block at base of vulval tumor (after Braun).

subject to considerable worry from their various afflictions, and they often make poor subjects for any form of local anæsthesia. Added to the terror of the operation is the embarrassment at being placed in the lithotomy position with perineum exposed. These subjective sensations should be allayed beforehand by the proper hypodermic medication of pantopon and scopolamin, just sufficient to convert an attitude of fear and worry to one of indifference.

The gynecological position on the operating table is at best quite uncomfortable, and may cause pain, particularly in obese women. If the patient shows signs of restlessness and discomfort during the course of the operation, it is more likely due to the position of the legs than to the manipulations of the operator, especially when the legs are suspended by the usual foot straps rather than being supported by the more comfortable leg holders. The adjustable leg holders with pneumatic cushions as employed by Farr greatly contribute to the comfort of the patient in this position. Her comfort may be further enhanced by the employment of deeper mattresses on the operating table and the use of regular pillows. With proper preliminary hypodermics, special provision for the patient's comfort on the table, and a tactful assistant to sit at her head and control her attention, a patient who otherwise would be regarded as a poor subject for local anæsthesia may be converted into an enthusiastic advocate of the method.

Surgery of the floor of the pelvis and of the viscera, in the female, forms a large part of the operative work of the general surgeon of the present time. The perineum offers a wide field for operations under local anæsthesia. The external and readily accessible parts are quite

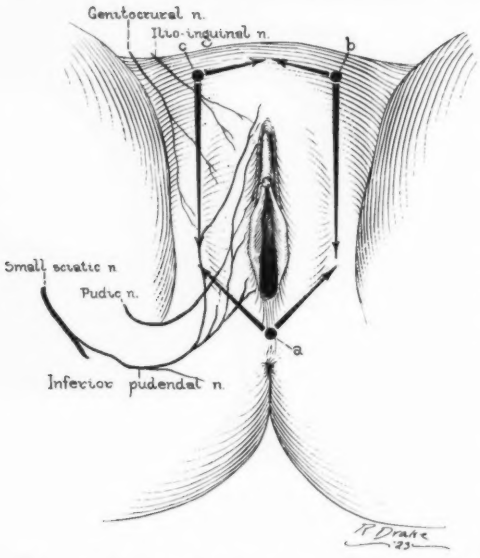


Fig. 2. Field block of entire vulva. *a*, perineal wheal; *b* and *c*, pubic wheals.

suitable for infiltration methods, while the deeper and more extensive operations may with skill and gentleness be painlessly performed under field block, or nerve block methods. Operations in this highly sensitive area must be performed with great care, and it naturally follows that any method of local anæsthesia in this region must be executed with delicacy, accuracy, and thoroughness to insure a successful outcome.

Operations under terminal infiltration and field block. The superficial operations on the perineum and anus may be quite satisfactorily performed under terminal infiltration. Cysts and solid benign tumors of all kinds, both on the labia majora and labia minora may be removed by circular field block, with deep fanwise injections of 0.5 per cent procain-adrenalin solution under the tumor (Fig. 1). A circular plane of anæsthetic fluid is thus projected from points around the base, entirely underneath the tumor, which interrupts conductivity in all nerve filaments passing through it. Complete extirpation of the vulva, as for example in elephantiasis, may also be performed by circular field block (Fig. 2). Injections may be made from three wheals: the perineal wheal *a*, is between the anus and vulvar orifice, while pubic wheals *b* and *c*, mark the pubic spines. From these points, fanwise injections are made in the direction of the arrows and toward the vulvar orifice, while the two fingers of the left hand in the vagina guard the position of the needle with respect to vaginal mucosa. In case of malignant tumors of the vulva it is more advisable to anæsthetize by a method which will be described.

Cervical and anal polypi and other benign superficial tumors of the perineum may be removed by infiltration of their bases. Urethral caruncles can be painlessly removed by surface anæsthesia with cocaine (7). A swab of cotton on a toothpick, saturated in 10 per cent cocaine solution and lubricated with a soluble lubricant, inserted into the urethra and left for 10 minutes, will completely anæsthetize the caruncle.

Superficial perineal fistulæ and fistula *in ano*, when not too painful and in which the course of the fistulous tract is definitely determined, may be encased by a wall of anæsthetic solution (Fig. 3). In most cases of fistula *in ano*, however, the surgeon must resort to other methods. When the fistulous tract must be explored and when dilatation of the anus is necessary, a considerably larger field must be anæsthetized. Infiltration may also be difficult, because of the great amount of scar tissue and tortuosity of the tract, particularly when previous operation has been performed.

In most cases of hæmorrhoidectomy and anal fissure, circumferential injection of the terminal rectum as first practiced by Reclus, is very satisfactory. The technique is so simple and quickly

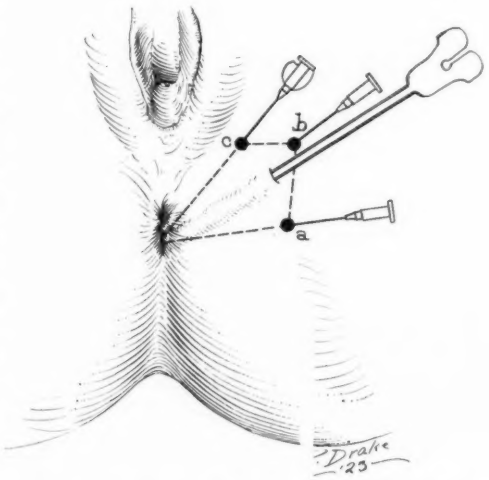


Fig. 3. Technique of injections for superficial fistula *in ano*.

executed that many surgeons employ it in preference to a general anæsthesia (8). A diamond-shaped area is marked off by four wheals (Fig. 4) with the anus in the center. From these points a 0.5 per cent solution of procaine-adrenalin is injected with an 8 centimeter needle. Deep, fanwise injections are made from these four points directed by a guiding finger in the rectum. These points are then connected by subcutaneous injections, so that when the technique is accurately performed, a wall of anæsthetic fluid the shape of a hollow cylinder, has been made to encase the terminal rectum (Fig. 5). Usually 100 to 125 cubic centimeters of solution is sufficient. At the conclusion of the injection the sphincters are flaccid, and the operation may begin within 5 minutes. Often in cases of anal fissure and in acutely inflamed hæmorrhoids, however, the finger cannot be tolerated in the rectum because of intense pain. The practice of inserting the finger into the rectum is not without risk of septic contamination, so that other methods are often employed.

Perineorrhaphy for small perineal tears may be performed under local infiltration of the tissues in the immediate neighborhood of the defect. Infiltration is begun from a dermal wheal in the middle of the mucocutaneous juncture, and continued along it somewhat farther than the desired extent of the incision on each side (Fig. 6). With the aid of a guiding finger in the rectum, deep, fanwise injections are made into the recto-vaginal septum, and extended to the bony walls of the pelvis laterally. From 100 to 150 cubic centimeters of 0.5 per cent procaine-adrenalin solution is employed, depending on the extent of the defect. In case of a large defect, however, the retraction necessary for exposure in a rather deep cavity, and the pull necessary in approximating muscles and fascia often produces intolerable pain. For this reason repair of extensive perineal tears is more effectively performed under nerve block methods.

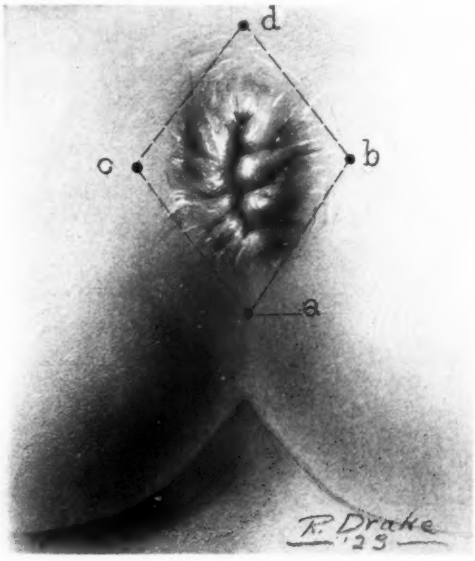


Fig. 4. Circular injections around terminal rectum and anus.

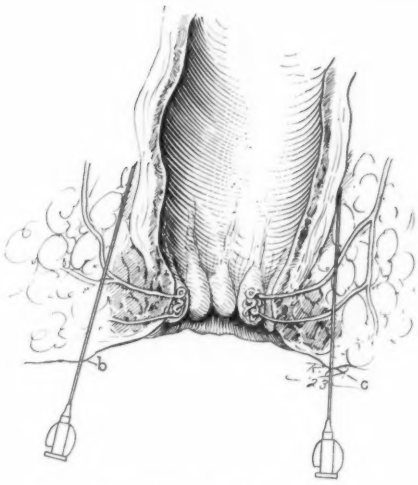


Fig. 5. Circuminjection of terminal rectum.

SACRAL BLOCK METHODS

The performance of more extensive operations on the pelvic floor and viscera than those thus far described, is often beset with difficulties when attempted under local infiltration methods. The most difficult problem in the deeper operations is the prevention of traction pain. Seizing the levator muscles may cause deep-seated pain which cannot be overcome by additional injections. In bringing the uterus down for tracheolorrhaphy, and in Watkin's interposition operation or vaginal hysterectomy, traction causes pain from tension on the pelvic peritoneum and broad ligaments. In other regions of the body infiltration could be made to include a wider area, but this is impracticable in the deeper perineal operations because of insufficient exposure and lateral limitation of operative field by the bony pelvis.

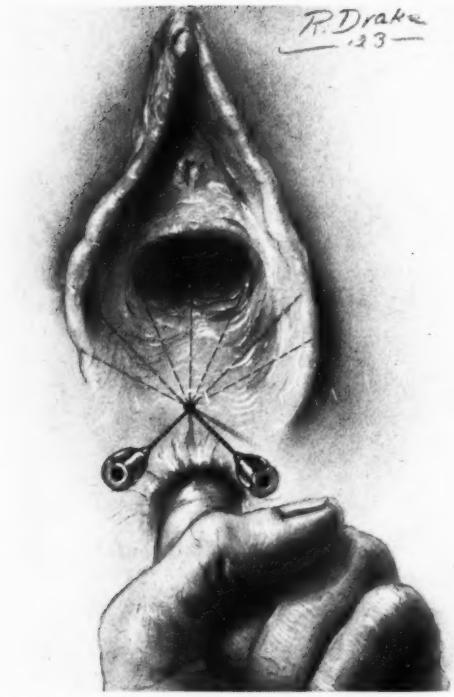


Fig. 6. Fanwise injections into the rectovaginal septum for perineorrhaphy.

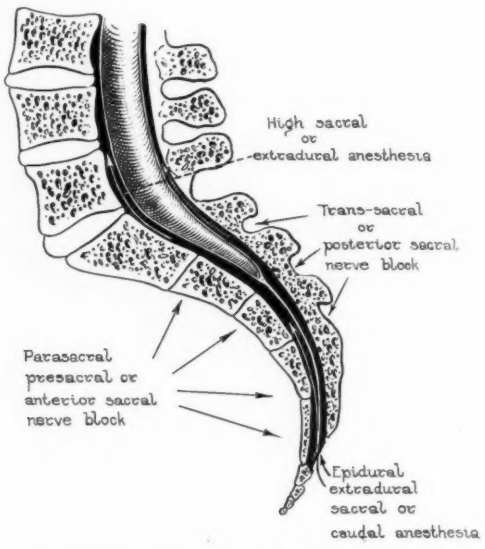


Fig. 7. Diagram illustrating different methods of approach in blocking sacral nerves.

By blocking the sacral nerves close to their points of exit at the sacral canal before the plexuses are formed, a much wider and deeper area may be anæsthetized, thus greatly facilitating surgical manipulation. Block of these nerves may be accomplished by (1) paraneural injection of the nerve trunks at their exits from the anterior sacral foramina, called parasacral, presacral, and anterior sacral nerve block; (2) the injection of an anæsthetic solution into the epidural space of the sacral canal, the procedure being known as epidural, sacral, extradural, and caudal anæsthesia; and (3) injections into the posterior sacral foramina, called posterior sacral, or transsacral nerve block (Fig. 7).

PARASACRAL NERVE BLOCK

In parasacral anæsthesia the patient is placed in the lithotomy position and injections made through the perineum into the hollow of the sacrum anteriorly. Dermal wheals are raised (Fig. 8) about 2 centimeters from the median line, at the level of the sacrococcygeal articulation. A longer needle, from 8 to 10 centimeters, is then introduced, and the way is felt past the edge of the sacrum and along its anterior surface, parallel to the median line to the height of the second foramen. The first sacral foramen is located by a separate insertion in which the needle is directed toward the innominate line. Both sides are similarly injected, after which a final infiltration of tissues between the coccyx and rectum is made. Usually about 100 cubic centimeters of 1 per cent procaine-adrenalin is required, although more recently Braun recommends the use of 0.5 per cent, 100 cubic centimeters being injected on each side. During the injections a finger in the rectum may be used to guide the direction of the needle.

The main objection to this method is the uncertainty of results. While Braun, the originator of the method, recommends it for operative work on the perineum, he also infiltrates locally, thus showing the inadequacy of the method when used alone. Very few series of cases are reported demonstrating the efficiency of the method. Tolken reports a series of 43 cases in none of which was it necessary to resort to inhalation narcosis. There was considerable pain in two instances, however, and he also usually infiltrated locally, so that there may have been other cases in which anæsthesia from the parasacral block alone was insufficient.

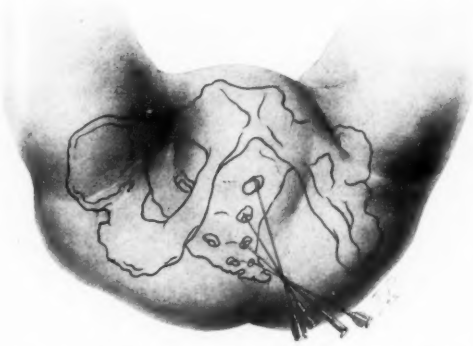


Fig. 8. Parasacral nerve block, showing method of approach to anterior sacral foramina.

The passage of needles through the perineum according to the parasacral or presacral method is not without an element of local danger. The rectum, even when empty, fills the concavity of the sacrum, and when it is bound down or partially fixed by pelvic adhesions, or displaced by pressure from neighboring structures, the risk of perforation cannot be denied. Infection may also be spread by the passage of the needles when a septic area is traversed. Similarly, the possible dissemination of cancer cells from secondarily involved perirectal lymph glands in cancer of the rectum must be kept in mind.

SACRAL NERVE BLOCK BY EPIDURAL INJECTIONS

Blocking the sacral plexus by intrasacral injections is a very simple and practical procedure. The anæsthetic solution is injected into the epidural space, the lower part of the sacral canal, a cavity from 6 to 9 centimeters long between the second and the fifth sacral vertebræ, and below the termination of the dura (Fig. 9). The upper portion of the sacral canal is occupied by the dural sac, which terminates at the lower border of the second sacral vertebra, while the lower end of the epidural space is marked by the hiatus sacralis, a triangular opening on the dorsum of the sacrum just above its juncture with the coccyx. This hiatus, which is due to failure of the dorsal arches of the sacral segments to coalesce, varies greatly in size depending on the degree of closure of the dorsal arches. If only the last or fifth arch is wanting, the opening is small. Cases have been encountered in which partial closure of the fifth arch may leave an opening just sufficient to admit a spinal needle. It is in such cases as these that ossification in the occluding sacrococcygeal membrane completely closes this aperture. Ordinarily, however, the hiatus is triangular in shape, the base being limited by the sacral cornua, usually 1 centimeter apart, while the apex is marked by the fourth sacral spine, about 1.5 to 2 centimeter distant from the base (Fig. 10).

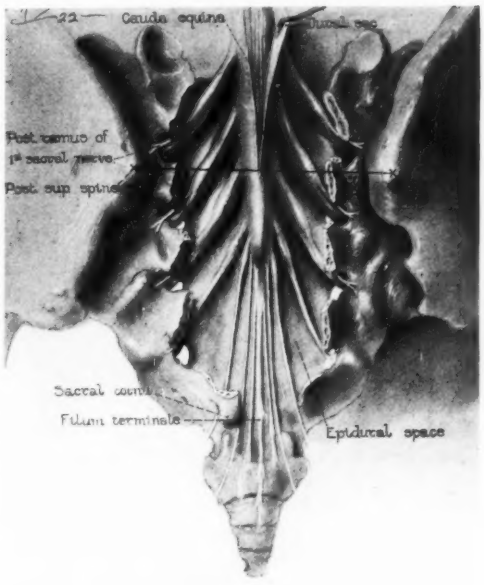


Fig. 9. Anatomy of epidural space. Sacral laminæ have been entirely removed. The fatty areolar tissue and lymphatic and venous plexuses normally filling up this space have also been removed, leaving the dura and nerve trunks in position.

In making the injection, the patient is placed in the ventral recumbent position with a cushion under the hips, which elevates the buttocks and accentuates bony landmarks (Fig. 11). The index finger of the left hand then identifies the sacral cornua on either side, and somewhat higher the fourth sacral spine, thus defining the hiatus. A dermal wheal is placed within this triangle, and the subcutaneous tissues and sacrococcygeal membrane infiltrated. A fine spinal puncture needle is introduced through the skin with bevel upward, and at an angle of from 20 to 30 degrees. The needle will be felt to pierce a dense membrane, then strike the bone of the anterior wall. It is then withdrawn from 1 to 2 millimeters, depressed from 20 to 30 degrees farther, and advanced upward 3 to 5 centimeters. If blood or spinal fluid escapes on removing the stylet, or on aspiration, the needle should be slightly withdrawn, or its position changed until these cease to flow.

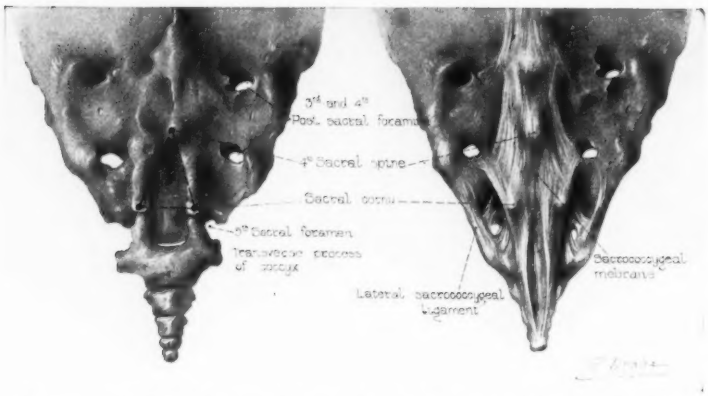


Fig. 10. Anatomy of the sacral hiatus. In the figure to the left (*) marks the site of puncture for entrance into the canal. To the right the hiatus is covered with the sacrococcygeal or obturator membrane.

The injection of the solution is then made very slowly and gently, the needle being gradually withdrawn, or its position changed, until, at the completion of the injection, the needle is just inside the sacrococcygeal membrane.

The quantity and percentage strength of the novocaine solution employed varies in the hands of different operators. Laewen, who first demonstrated the practicability of the method for operative work, recommends from 20 to 25 cubic centimeters of a 2 per cent solution of novocaine and adrenalin, with the addition of sodium chloride and sodium bicarbonate. He also employs from 25 to 35 cubic centimeters of a 1.5 per cent solution of novocaine. Many other formulas have been proposed. Schlimpert and Schneider employed 50 cubic centimeters of 1 per cent strength for gynecological and obstetrical work. Clinical experience indicates more favorable results with larger amounts of the weaker solutions.

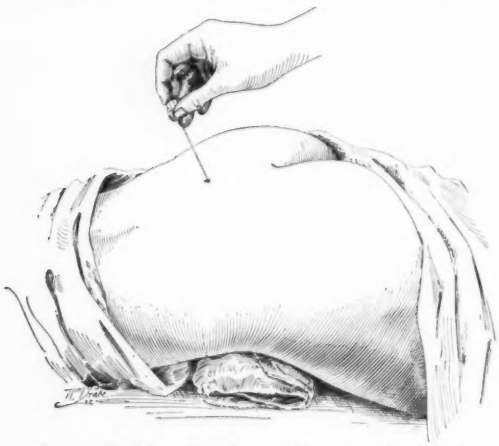


Fig. 11. Position of patient and operator for injection of sacral nerves by the posterior route.

The chief disadvantage of sacral anæsthesia in gynecological operations is its failure in a certain percentage of cases. While the proportion of failures will vary according to the accuracy with which the technique is performed, the method is accompanied by a certain incidence of failures even in the hands of the expert. The anæsthetic medium, because of the curvature of the sacrum, is deposited nearer the posterior wall than the anterior, while the anterior divisions of the nerves lie contiguous with the anterior wall. Near the middle point of the space, the nerve trunks are enclosed in tubular prolongations of the dura as they leave the dural sac, thus protecting them from contact with the anæsthetic medium. As the trunks proceed laterally, however, the contribution of the dura to the perineum tends to diminish, until at the lateral foramina it is no longer evident. It is at this point, then, that the nerve trunk will be most easily penetrated by the anæsthetic solution. The solution must thus diffuse through the content of the epidural space, consisting of fatty areolar tissue, and lymphatic and venous plexuses, before physiological block of the nerve trunks will be effected. Kehrer, in 140 gynecologic cases, found the anæsthesia insufficient in 10 per cent, and absent in 8 per cent. These operations included most operations on the entire pelvic floor and viscera. It was usually the deeper

operations, however, such as vaginal hysterectomy in which anæsthesia was insufficient.

Even when successful, the height of anæsthesia is variable, extending from the anal margin in light anæsthesia to complete motor paralysis of the legs in the extreme cases. It is obvious that anæsthesia will appear first in the lowest of the sacral nerve trunks, because these are smaller in size, and have a longer course nearer the middle line in the portion of the sacral canal which is smallest in volume, all features favoring bathing of the nerve trunks with the anæsthetic solution. If one who uses sacral anæsthesia is ready to supplement the sacral blocking by local infiltration, when required, the failures do not work so much of a hardship.

Another disadvantage is the appearance of toxic symptoms. All patients react more or less to the injection of procaine-adrenalin solutions into the sacral canal, the severity of the reaction being proportional to the strength of the solution used, the quantity of adrenalin, the quantity of solution, and the speed with which the injection is made. Rapid pulse and palpitation of the heart are the most frequent symptoms, and may be accompanied by an increase in respiration and dyspnœa. Nausea and vomiting, and sometimes even collapse, may occur. Such untoward symptoms start during the injection and last only a few minutes, clearing up without actual treatment, if the injection is stopped for a time and resumed very slowly.

Sacral anæsthesia is valuable in the more superficial operations on the perineum and terminal rectum. It is the method of choice for cystoscopy with or without fulguration, for radium treatment, for the carcinomatous bladder, and for litholapaxy and painful proctoscopy. One of the most satisfactory fields for sacral anæsthesia is in inflamed bladder, especially of tuberculous origin. Occasionally in fulgurating in cases of benign papilloma of the bladder, the mucosa is too irritable to permit sufficient distention or extensive fulguration. Sacral anæsthesia is usually satisfactory in these cases permitting an unhurried, complete examination. In case of litholapaxy, it is necessary to remember that the musculature of the bladder is partially paralyzed and cannot readily expel the water and particles of crushed stone. For urological manipulative work, partial failures do not cause great inconvenience, since these procedures may be accomplished with an anæsthesia insufficient for operative work.

Dilatation and curettage, cauterization of the cervix, and insertion of the Baldwin tube, may be painlessly performed, provided gentleness is used in manipulation. The effect of severe traction on the cervix in bringing the uterus down may be transmitted to territories beyond the anæsthetized area, however, the sterilization of the vaginal cavity and insertion of vaginal retractors is painless. This method is more efficient than injections around the cervix and into the parametrium. Epidural injections are also indicated in the treatment of sciatica, coccyalgia, sexual neurosis, tabes dorsalis, and in intractable pruritis of the anus and vulva. Dilatation of anal strictures, hæmorrhoidectomy, and excision of and superficial fistula-in-ano may be successfully performed in most cases. When perfect anæsthesia results, relaxation of the anal sphincters is a characteristic feature. The occasional failures to produce anæsthesia as high as the second sacral nerve, and the slowness with which the anæsthesia sets in are disadvantages which may be overcome by peri-anal infiltration when needed.

TRANSSACRAL NERVE BLOCK

Block of the sacral nerves by the transsacral method, in the opinion of many operators, has overcome many of the inconveniences and disadvantages of parasacral and sacral anæsthesia (28). The anæsthesia produced by the parasacral method is said to be similar to that produced by the transsacral method, since the nerves involved are the same, except that in the parasacral method the posterior primary divisions are not reached. Differences exist, however, in the quality of the anæsthesia and its duration, and this should be remembered when comparing the results of both procedures (24). In the transsacral method the increased pressure on the nerve trunks and the limitation of lateral spread of the solution by the bony walls of the foramina, which also results in retention of the fluid within the foramina for a longer time, establishes more favorable conditions for rapid and prolonged anæsthesia. The presacral method is anatomically less precise and less aseptic.

Clinical experience indicates that the best results are obtained by the use of a very low epidural injection for anæsthesia of the fifth sacral and anococcygeal nerves and transsacral block of the upper four sacral nerves (29). The association in this manner of the epidural and transsacral methods has been termed by Labat "sacral block." This term has been previously applied to blocking of sacral nerves by epidural injections (16), so that the introduction of a double meaning instead of clarifying the terminology in a field where there is already a plethora of names, adds to the confusion.

This technique gives a uniformly satisfactory anæsthesia, the height of which is definitely limited. Injection of 20 to 25 cubic centimeters of a 1 per cent procaine-adrenalin solution into the epidural space is performed, as already described. This usually creates more favorable conditions for transsacral block in that the manipulations are almost painless, due to anæsthesia of posterior divisions. With the patient in the same position (Fig. 11), transsacral block is carried out with the same solution.

In locating the lateral sacral foramina (9), use is made of the fact that they lie in the same straight line, and are nearly equidistant from each other (Fig. 9), the distance decreasing somewhat from above downward, and that their position bears constant relationship to the most prominent bony landmarks of this region, the posterior superior iliac spines and the sacral cornua. A dermal wheal, placed just laterally and below the sacral cornu, locates the sacral notch on the lower margin of the sacrum in which the fifth sacral nerve lies. Palpating the most prominent point of the posterior superior iliac spine, with the left hand, another dermal wheal is placed 2.5 centimeters medial, and about 1 centimeter downward, which marks the position of the second sacral foramen (Fig. 12). The space between these two wheals is then divided into three parts by two more wheals, then a fifth is placed the same distance above the second and in the same straight line, completing the superficial designation of the five foramina.

Search for foramina is then made by advancing the needle directly downward and somewhat inward in a direction thought to be perpendicular to the tangent of the sacrum at that point (Fig. 11). It usually comes in contact with bone during the first few attempts, the distance from the skin to the posterior surface of the sacrum being estimated in this way. When, after repeated search, the needle seems to perforate a membrane, advancing farther than before, still without encountering bony resistance, it has passed into the foramen. Greater inclination of the needle to the skin surface is necessary in searching for the highest foramina, due to the downward curvature of the sacrum, and greater thickness of overlying soft tissues. The size of foramina and nerve trunks also decreases from above downward, necessitating the injection of larger amounts of solution in the higher foramina. The quantity for each successive foramen is thus reduced by 1 cubic centimeter, that is 7, 6, 5, 4, and 3 cubic centimeters for the first to the fifth foramina respectively. From 60 to 80 cubic centimeters of 1 per cent solution is sufficient for complete transsacral block. Anæsthesia is usually complete at the conclusion of the last injection, and lasts from 2 to 4 hours. There has been no untoward reaction of the patient in our experience, provided the correct technique was employed and operation limited to pelvic floor and viscera.

SCOPE OF OPERATIVE WORK

The extent of anæsthesia is best appreciated by a consideration of the operations that have been painlessly performed with this method on the pelvic floor and viscera of the female. While all of the operations herein detailed do not properly belong to the field of gynecology, their consideration is of value in that the parts concerned are innervated by sacral nerves and constitute a part of the pelvic floor, all of which is involved in obstetrics. In surgery of the rectum it has been repeatedly employed in hæmorrhoidectomy, the usual type of operation being clamp and cautery of the internal hæmorrhoids, and excision and suture of the external. Relaxation of the sphincters and muscles of the pelvic diaphragm are features especially favorable to surgery of the terminal rectum. Plastic operations on the anal sphincters, removal of rectal polypi, dilatation of rectal strictures, excision of specimens from rectal tumors for diagnosis, and amputations of the prolapsed rectum, have been performed many times under block of the lower four sacral nerves by the posterior route. It has been employed in posterior resection of the carcinomatous rectum with removal of the coccyx and fifth sacral segment. The single stage resections with sacral anus, and the second stage resections after preliminary colostomy have been performed; for this operation all five sacral nerves are injected, it being unnecessary to inject the lower three lumbar nerves, as insisted on by certain authors. Block of the sacral nerves alone anæsthetizes the pelvic peritoneum, so that it can be opened and removed from the rectum and closed again painlessly. If there is intolerable pain during the operation, which is unusual, it is due to the traction on the bowel necessary to bring a high-lying growth down so that clamps may be applied above it. This pain is probably due to excessive pulling on the mesosigmoid, involving the hypogastric plexuses of nerves, and cannot be controlled by block of the three lower lumbar nerves. One per cent procaine-adrenalin solution is usually employed, although in old, feeble, and cachectic women, it is not necessary to employ the full strength of dose, as for the more vigorous patient. Anæsthesia is more readily induced

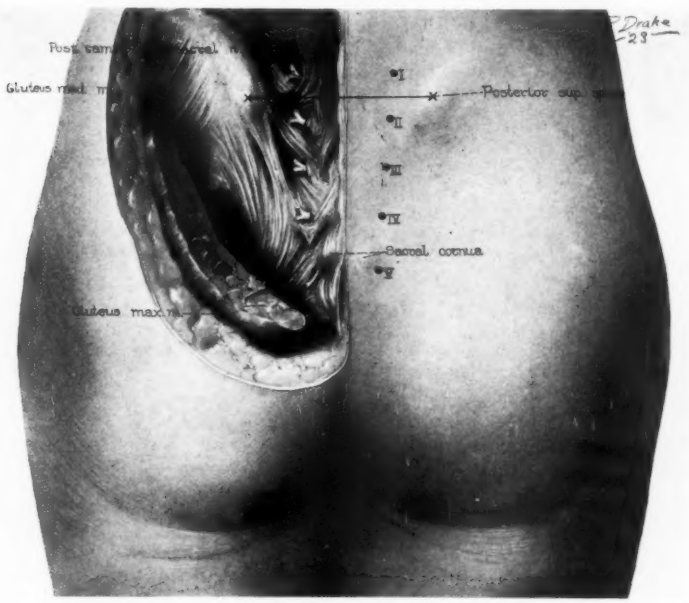


Fig. 12. Transsacral nerve block. On the right side is shown the relation of cutaneous points to posterior superior spines and sacral cornua. Dissection on the left side shows posterior divisions of sacral nerves and sacral foramina. Note the position of the interspinous line with regard to first and second sacral foramina.

in the feeble, so that the strength of the solution may be reduced to 0.5 per cent, and a slightly greater quantity employed.

The patient's position on the table is awkward, and precautions should be taken to make it as comfortable as possible. Special care should be exercised in the two-stage operation, so that weight on the preliminary colostomy does not cause pain. Often this is the only thing of which the patient complains during the entire operation. Growths have been extirpated as high as the rectosigmoid juncture, with removal of perirectal tissues. In the two-stage operations the pelvic peritoneum was usually opened and closed. In several cases the posterior wall of the vagina was adherent to the growth and removed with it. In others, adhesions to the posterior wall of the uterus were separated, and the uterus then brought down into the defect. In one instance a posterior resection was performed on a woman 4 months' pregnant, with perfectly normal convalescence and no disturbance to the pregnancy.

Multiple infected perineal fistulæ-in-ano have been operated on, the usual type of operation being wide excision and packing. The course of the tracts may be painlessly explored, widely excised, and packed, or closed, as indicated. In such cases infiltration of an infected field would be unwise.

Operations on the genital tract have included excision of carcinomatous ulcers of the vulva, perineorrhaphy, complete vaginectomy, the Bovée operation for cystocele, trachelorrhaphy, dilatation and curettage with insertion of the Baldwin tube, repair of vesicovaginal fistulæ, excision of vaginal tumors, the Watkin's interposition operation, and the Mayo vaginal hysterectomy.

In malignant growths of the vulva, it is best not to rely on circular infiltration, because of the wide extirpation necessary and the possibility of spread of cancerous foci. Transsacral block affords a very wide area of anæsthesia, very efficient in these cases, unless the external anterior parts of the labia majora are to be included in the operative field. In the latter case infiltration from the pubic spines must be practiced (Fig. 2) besides the transsacral block.

Vaginectomy has been performed in relaxed pelvic floors after hysterectomy, in which the pelvic peritoneum was painlessly opened and closed. The Bovée and Clark operations for

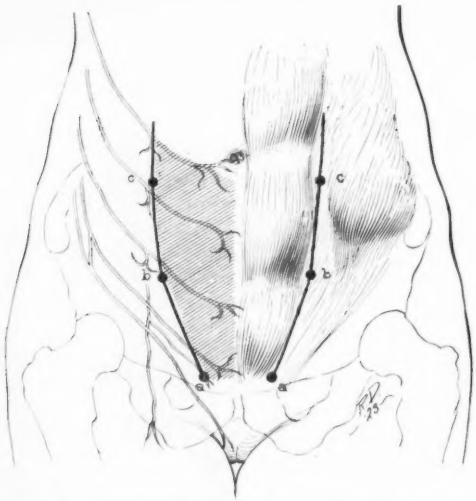


Fig. 13. Suprapubic field block. Wheals *a*, *b*, and *c*, mark the sites of injection along the lateral margins of the rectus muscles.

cystocele have been painlessly performed. Multiple perineal operations have been performed on the same patient under the same anæsthesia such as dilatation and curettage, trachelorrhaphy, perineorrhaphy, and hæmorrhoidectomy.

BORDERLINE OF USEFULNESS

It is in the Watkin's interposition operation and the Mayo vaginal hysterectomy that the borderline of usefulness of the transsacral method is reached. In these operations, particularly the hysterectomy, the most difficult problem is the prevention of traction pain. Pulling of the uterus through the vaginal wound usually causes pain from tension on the broad ligaments. Nor can this trouble be remedied by parametric injection of the broad ligaments, since the same amount of tension is still present beyond the area infiltrated, the parametric injections serving only to anæsthetize the uterus itself. In cases of extreme relaxation, and in complete prolapse the anæsthesia is usually sufficient for hysterectomy, and may be followed by perineorrhaphy. In cases in which there is not complete anæsthesia the administration of a first stage ether anæsthesia during the deep manipulations, constitutes a combined method much safer than general narcosis alone.

PARAMETRIC ANÆSTHESIA

Attempts have been made at various times to render the entire uterus insensitive by parametric

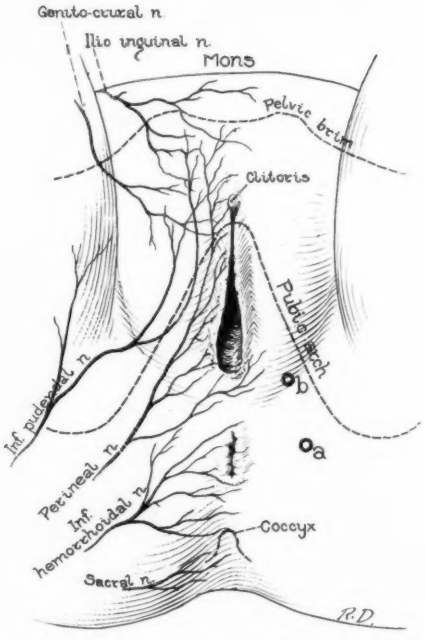


Fig. 14. Injections into perineum after King. Distribution of sensory nerves shown on the right side. On the left side *a*, and *b*, mark sites of puncture for the injections.

injections for such operations as vaginal hysterectomy. Ruge first described a systematic method for these injections. A long needle is inserted from 4 to 5 centimeters into the parametrium to the right and left of the cervix. It is directed slightly to the side in order to block the nerves which enter the parametrium as far as possible from the uterus, to obtain as extensive an anæsthesia of the pelvic floor as possible. In the same manner injections are made from points on the anterior and posterior vaginal vault. Injections are made with very fine needles and always while the needle is in motion. When these precautions are followed it is claimed that most vessels and any coils of intestine with which the needle may come in contact will be pushed aside and not injured.

While this method seems to have given satisfaction in the hands of its originator, it has been but very little employed by other surgeons operating under local anæsthesia. In many women, especially those with tense vaginas, some method of anæsthetizing this part must also be practiced, in order to permit sufficient distention and traction. The deep injections by this method are not

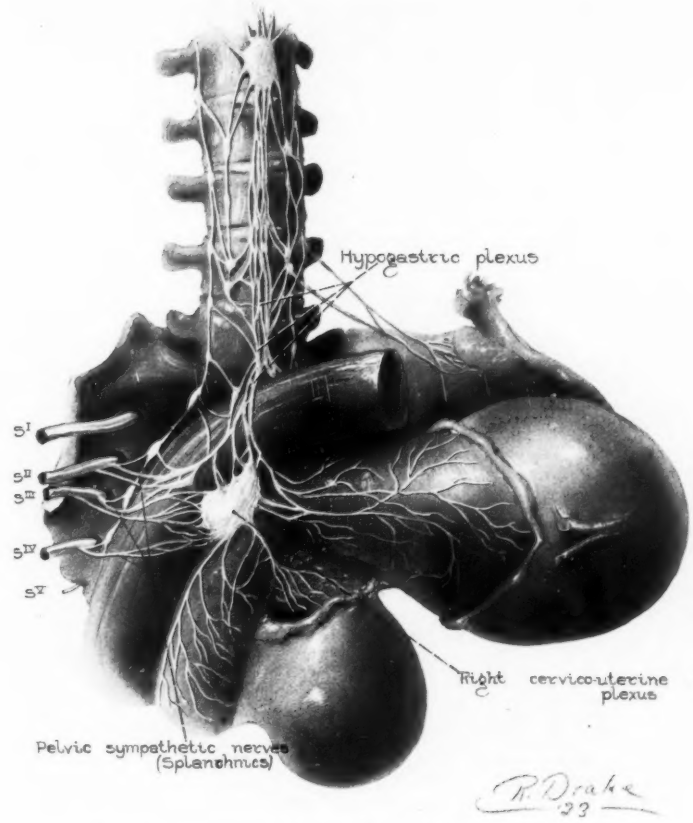


Fig. 15. Innervation of the pelvic organs after Frankenhaeuser.

without an element of danger of perforating rectum, bladder, or coils of intestine, since they are made without any reliable guide. When the normal anatomical relations are distorted by pelvic lesions, this danger is much greater, and septic foci may be punctured and disseminated by the passage of the needle. Even when properly performed, this technique does not avoid the transmission of traction on the uterus to the pelvic peritoneum sufficient to cause pain. For these reasons parametric injections have not become popular for uterine operations.

ABDOMINOPELVIC OPERATIONS

In operating within the abdominal cavity, only a limited number of gynecologic operations are feasible, and only then under very favorable conditions, such as thin relaxed abdominal walls, no acute inflammation or pelvic adhesions, but free mobility of the parts. The abdomen may be opened painlessly in the middle line after infiltration of the skin and subcutaneous tissues, then the aponeurosis, and lastly the preperitoneal tissue which also anæsthetizes the peritoneum. Laparotomy may also be performed under suprapubic field block, which is accomplished by distributing 0.5 per cent solution along the outer margins of the recti muscles in the same planes from the pubes to a little above the umbilicus. Wheals are placed above each pubic spine *a*, Figure 13, then along the outer margins of the rectus abdominalis muscles, *b* and *c*. The deep injections are first made from these wheals by repeated perforations of the aponeurosis at distances of about 1 centimeter and injection of about 2 cubic centimeters of solution. Perfora-

tion of the aponeurosis is easily recognized by the disappearance of the increased resistance offered by this dense layer to the passage of the needle. When these deep injections are completed, subcutaneous fanwise injections are made in the same plane joining the wheals together (Fig. 14). From wheal *b*, a longer needle is then passed obliquely downward toward the middle line and behind the symphysis pubis injecting, as the needle advances, until the space of Retzius is reached. Retractors must be employed with great caution, and extreme gentleness used in handling the viscera. Abdominal peritoneum and viscera being unanæsthetized, no packing of the abdominal cavity can be performed, no breaking up of adhesions nor grasping of the uterus with volsellum or other toothed instruments unless the points at which they are applied have first been infiltrated. The patient should breathe through her mouth in order to relax the abdominal walls. In the Trendelenburg position the bowels have a tendency to drop down toward the diaphragm and away from the operative field, thus affording the maximum of exposure. Certain operations are now possible by the aid of infiltration within the abdomen. Salpingo-oophorectomy may be performed when these parts are free, by infiltrating the broad ligaments and the pelvic and uterine attachments of these parts proximal to the line of incision on the anterior and posterior surfaces. Pedunculated ovarian cysts, when not adherent, may be removed by thorough infiltration of the pedicle. For the more extensive abdominopelvic operations, however, particularly hysterectomy, general narcosis is necessary for the intra-abdominal work. The addition of transsacral nerve block, and even the supplementing of this procedure by lumbar paravertebral nerve block does not solve the problem. Abdominal viscera are still unanæsthetized, and the exposure and traction necessary usually cause intolerable pain. Infiltration around the entire broad ligaments and uterus on the anterior and posterior surfaces, sufficient for hysterectomy, has been accomplished in only a few very favorable cases by men of widest experience in the handling of local anæsthesia problems, the thorough and comprehensive work of Farr constituting the only notable exception to this statement.

For most surgeons of wide experience local anæsthesia by whatever method induced, does not create an operative condition compatible with the employment of the appropriate surgical methods which are indicated in most abdominopelvic operations.

OPERATIONS ON THE BLADDER

Operations on the bladder, however, may be quite satisfactorily performed by suprapubic field block and transsacral nerve block. The problem here is not complicated by intra-abdominal anæsthesia, unless the peritoneum is opened. The suprapubic field block facilitates the use of retractors. The space of Retzius is anæsthetized by the anterior injections, and the block of sacral nerves anæsthetizes the bladder. Resection of malignant growths of the bladder may be performed by the transvesical route, also the excision of diverticula. When the peritoneal cavity is invaded, however, the anæsthesia is usually incomplete.

APPLICABILITY TO OBSTETRICS

The successful employment of sacral nerve block anæsthesia in gynecology, and in fact in operations involving the entire pelvic floor, naturally leads to the question of its practicability in obstetrics. Anæsthesia is as justifiable in obstetrical work as it is in operative gynecology; and in the more difficult cases it is indispensable. The fundamental requirements of an obstetrical anæsthesia, however, are widely different from those in gynecology, hence the anæsthetics and their methods of administration must likewise vary, in order to satisfy the special requirements in this particular field. In the selection of the anæsthetic, the general condition of the mother must first be considered, much as in gynecology. The possible influence of pulmonary, cardiac, and renal lesions, as well as the toxæmias of pregnancy may determine the question of safety to the mother. The second consideration must be the influence of the anæsthetic on the child, and the third, the effect on the powers of labor. The employment of a possible local anæsthesia should adequately fulfill the first and second of these requirements, and if it does not too greatly retard the progress of labor, its use should prove almost ideal. Another feature in anæsthesia in obstetrics, which should facilitate its use, is the fact that an anæsthetic is rarely necessary before the second stage. A cheerful and sympathetic demeanor with the proper encouragement from the physician and attendants will usually suffice throughout the first stage. It is certainly well to delay anæsthesia as long as practicable, and many labors may, of course, be easily conducted without any anæsthesia. With the beginning of the second stage, pain becomes much more intense, and when an anæsthetic is to be resorted to, a few whiffs are given during pains as the head descends. The demand for anæsthesia increases as labor

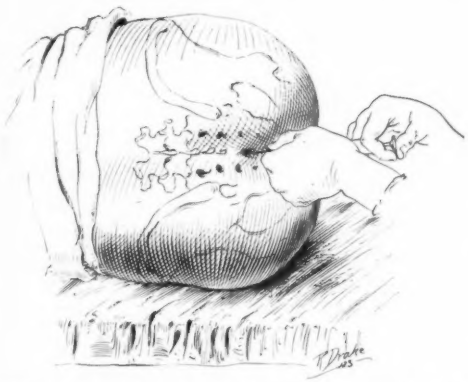


Fig. 16. Position of parturient woman for block of sacral nerves.

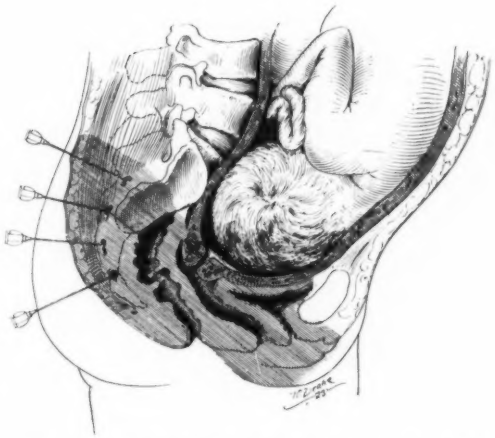


Fig. 17. Median longitudinal section of the pelvis anterior to the sacrum, with entire sacrum preserved. Needles in position for block of the second to fifth sacral nerves by the posterior route.

progresses, although a superficial anæsthesia is usually sufficient until the head passes through the vulva. It is at this point that the most extreme anguish is experienced, so that anæsthesia must be pushed to a true surgical degree, but stopped as soon as the head is born. Two degrees of anæsthesia are thus experienced: first, an anæsthesia in which pain is dulled or relieved with only a brief, or no loss of consciousness; and second, surgical anæsthesia in which consciousness is lost, and body rigidity is overcome.

But little attention has been paid to the application of local anæsthesia of the pelvic floor in obstetrics. In fact, most obstetricians regard local anæsthesia to be of very little value in the analgesias of childbirth. The topical application of cocaine solutions to the cervix produces a limited degree of anæsthesia during the stage of dilatation, not sufficient, however, to justify its employment. Besides the danger of sepsis from intravaginal manipulations, there is a possibility of constitutional toxic manifestations.

INJECTIONS INTO THE PERINEUM

Infiltration into the perineal tissues has also been practiced with but little benefit. Hoag recommends infiltration of the perineal tissues and the employment of nitrous-oxide-oxygen, thus applying the principle of "anociation" to the obstetric field. But scant anæsthesia results from infiltration methods, as regards control of pain during the second stage. While episiotomy and repair may be painlessly performed by this method, the entire pelvic floor must obviously be anæsthetized in order that the distention and tearing of these tissues caused by the escape of the head and shoulders from the vulva may take place painlessly. A somewhat wider area of anæsthesia results by block of the pudic nerve. Two sites of injection have been proposed. Ilmer first recommended block of this nerve on both sides of the medial surfaces of the inferior rami of the os ischii, a procedure since improved by King (Fig. 14). For operative procedures, this method is usually unsatisfactory. No extensive anæsthesia of the pelvic floor results, even though both pudic nerves are blocked at this point. Moreover, anatomical relations make blocking of this nerve a difficult procedure, because it is well covered on the inner surface of the os ischii by the obturator fascia of Allcock's canal, and it divides before its entrance into the ischiorectal fossa. The perineal method suggested by King has been tried by us in a limited number of cases with indifferent results.

The second method of blocking the pudic nerve is at a point farther back on the outer surface of the spine of the ischium. The ischial spine is palpated from in front, by way of the rectum. The needle is then introduced into the soft tissues of the perineum to one side of the rectum, and advanced until contact is taken with the anterior surface of the spine. The direction is then changed backward, and the needle advanced somewhat farther than before, to the outer surface of the spine, at which point the injection is made. Blocking of the pudic nerve by this method has never been widely

attempted because of the technical difficulty and uncertain results. Moreover, its application for the control of pain in the second stage of labor is hindered by the low lying head. Because of this feature the method is even more difficult to employ than in the field of gynecology.

LOCAL ANÆSTHETIC REQUIREMENTS

The most efficient local anæsthetic for obstetrics must be one that will anæsthetize the entire pelvic floor and those structures included within the pelvic girdle. The pain during dilatation of the cervix is not of the same intensity as that suffered by birth of the head through the perineum, and seldom requires anæsthesia of any sort. The suffering caused by the advancing presentation on the perineum is due to the stretching and tearing of the soft parts of the entire pelvic floor, this pain being, therefore, much more severe in primipara than multipara. Anæsthesia by injections into the perineum anæsthetizes only a part of the pelvic floor, so that, while minor surgical procedures on the perineum may be carried out successfully with this method, the extreme stretching tension and tearing of soft parts when the head is being born, must be transmitted beyond the anæsthetized area to a sufficient extent to cause pain. Surgical experience indicates that even when the methods of injecting into the perineum are successful, scant operative anæsthesia results unless the coccygeal plexus, superficial perineal rami, and posterior cutaneous femoral nerves are also blocked.

Block of the sacral nerves before the formation of the plexuses should afford best relief from pains of childbirth, since its use in gynecology has shown that the entire pelvic floor and viscera may be anæsthetized. This method was first employed by epidural injections of novocain by Stockel in 1909. His best results were obtained by the injection of 30 cubic centimeters of 0.5 per cent solution, an amount and strength insufficient for surgical anæsthesia. Among other benefits he claimed to have reduced the severity of the pains and in four cases terminated labor by the application of low forceps.

Schlimpert and Schneider next employed the method in the entire field of gynecology and obstetrics. They used the formula perfected by Lowen and Gros, and repeatedly demonstrated its value in operative and manipulative obstetrical work. As a means of control of the second stage pain in normal birth, they found that the progress of labor was often retarded, so that the child was often born with the usual amount of pain after the anæsthetic effect of the epidural injection had worn off. Following the publication of Schlimpert and Schneider, other obstetricians employed the method, most of whom reported very favorable results. Prominent among these are Ambrosini, Piantoni, Ferreyra, de Kervily, Perrill, and Schellekens. In view of the valuable results reported by these men, it is strange that so little attention has been given to this method by American obstetricians. The disadvantages are largely those which obtain in gynecology, namely, the small percentage of failures, variable height of anæsthesia in successful cases and occasional toxic manifestations. These disadvantages have been overcome by the transsacral method plus a low epidural injection, although there is no record of this method ever having been employed in obstetrics. Even those surgeons who have employed local anæsthesia most widely neglect to attempt it in labor. Allen makes but scant mention of the method, while Labat entirely ignores the possibilities of nerve block anæsthesia in obstetrics.

Anatomy and physiology. For an understanding of the effect of sacral nerve block on the pelvic floor, and powers of labor, a consideration of the nerve supply is valuable. The innervation of the pelvic floor is supplied by the second, third, fourth, and fifth sacral nerves and anococcygeal filaments passing out directly through the sacral hiatus. The first pair of sacral nerves does not take part in the innervation of the pelvic floor proper, except possibly a contribution to sensory innervation of pelvic peritoneum, but distributes principally to the lower extremities and buttocks. Sacral sympathetic efferent fibers leave the spinal cord with the anterior roots of the second, third, and fourth sacral nerves (Fig. 15). These fibers are collected in the pelvis into the nervi erigentes, or pelvic nerves, which proceed to the pelvic sympathetic plexuses from which fibers are distributed to the pelvic viscera. Vasodilators are distributed to these organs, while inhibitory fibers probably pass to the smooth musculature. Afferent sympathetic fibers also conduct impulses from the pelvic viscera to the second, third, and fourth sacral nerves.

The nerve supply of the uterus is derived partly from the cerebrospinal and partly from the sympathetic. The cerebrospinal is represented mainly by the third and fourth sacral nerves, principally sensory. More important is the sympathetic nerve supply. A large plexus is located on either side of the cervix, which is composed of branches from the sacral sympathetics and the hypogastric plexuses. Large plexuses of nerve filaments pass down on either side of the rectum,

and following the course of the uterosacral ligaments, terminate in the cervical plexuses.

Little is known of the nervous mechanism of labor contractions. A nerve center is believed to exist in the cortex, one in the medulla, one in the cerebellum, and one in the lumbar enlargement of the cord, because irritation at these points causes uterine contractions. Delivery has been shown to occur in animals when the nerves connecting the uterus to the central nervous system have been severed. The primary stimulus for uterine contractions is, therefore, in the uterus itself, although under normal conditions the contractions of this organ are doubtless considerably influenced by reflex effects through its extrinsic nerve supply, and probably also by substances brought to the uterus by the circulating blood, or originating in the fetus itself.

On the basis of anatomical and physiological reasons, block of the second, third, fourth, and fifth sacral and the anococcygeal nerves should have the following effect when employed in the second stage, or latter part of the second stage of labor.

1. Block of spinal afferent sensory fibers should result in a loss of sensation of the structures of the pelvic floor.

2. Block of spinal efferent motor fibers should abolish any spasm of the pelvic floor musculature, resulting in complete relaxation.

3. Block of sympathetics distributing to the uterine musculature and vessel walls, by abolishing vasodilator and inhibitory impulses, should produce contraction of the smooth musculature and blood vessels of the uterus. The sacral sympathetics make up but a small part of the sympathetic innervation of the uterus, however, so that the effect of block of the sacral sympathetics alone would be difficult to foretell.

SERIES OF OBSTETRIC CASES

Observations were made on 90 patients in the obstetrical wards of the Cook County Hospital in Chicago.[1] The comparative merits of the various methods of approach to sacral nerves were studied, and the values of the various formulas for epidural injections were determined. No preliminary hypodermic narcosis was employed, so that whatever alleviation of pain might result could be due to the nerve block anæsthesia alone. Special care was exercised in observations as to duration of anæsthesia and the effect on the progress of labor. The value as an anæsthetic was determined from two standpoints; for obstetric operations, and as a means of abolishing the pain of normal labor.

Methods employed. Transsacral block of the lower four sacral nerves with a low epidural injection was the first procedure attempted. For obstetrical work the patient cannot be placed in the usual ventral decubitus position, but the injections must be made while she is on her side in a modified Sims position (Fig. 16). The patient is instructed to arch her back and bring her knees upward toward her chin as much as possible, which stretches the soft tissues overlying the bony prominences of the sacrum, making them more easily palpable. In this position the sacrum is displaced upward, while overlying soft tissues by their own weight hang lower in relation to the bony framework. The fall of the buttocks displaces the gluteal cleft at least 1 centimeter lower than the sacral hiatus. A nickeloid spinal puncture needle is the best for the epidural injection, as it will bend readily and not break. There is danger of breaking a brittle steel needle in the sacral canal, as it is impossible for most patients to remain entirely quiet during a severe labor pain, while a few will not co-operate at all, tossing about in bed until the pain ceases.

In the first series of 16 patients anæsthetized by this method during delivery, from 60 to 85 cubic centimeters of 1 per cent procaine in half physiologic salt solution was employed (Formula 1). Ten minims of adrenalin to 100 cubic centimeters of solution was employed in all cases. The average duration of anæsthesia was 2 hours and 24 minutes, as determined by testing cutaneous sensation of the perineum with a clamp, a somewhat shorter period of anæsthesia than was thought to be available from our experiences in general surgery. In an attempt to prolong the period of anæsthesia sodium bicarbonate was added to the solution.

The second series of cases was anæsthetized by the same procedure as the first, except that 0.4 per cent sodium bicarbonate was added (Formula 2). Seventeen patients were anæsthetized in this series, using the same quantities as in the first series of cases. The average duration of anæsthesia here was 2 hours and 2 minutes, showing no advantage gained by the addition of sodium bicarbonate.

These two series of cases serve also to emphasize certain difficulties in the induction of transsacral nerve block in parturient women. The lateral recumbent position produces a distortion of normal landmarks often necessitating prolonged

[1] The authors wish to thank Drs. D. E. Hillis, H. F. Lewis, and W. G. Lee for permission to perform this work on the patients of their services, and Dr. Karl A. Meyer and Mr. Michael Zimmer for affording them the use of the hospital facilities.

TABLE I.—QUALITY OF ANÆSTHESIA RESULTING FROM DIFFERENT METHODS

	Complete pelvic floor anæsthesia	Partial pelvic floor anæsthesia	Average duration in successful cases	Failure	Cases in which labor outlasted anæsthesia	Cases re-injected
Formula 1 Transsacral method	15	1	2 hours, 24 minutes		4	
Formula 2 Transsacral method	17		2 hours, 2 minutes		4	4
Formula 3 Epidural injection	19	3	1 hour, 57 minutes		4	4
Formula 4 Epidural injection	9	3	1 hour, 55 minutes		1	1
Formula 5 Epidural injection	12		2 hours, 10 minutes	1	4	4
Formula 6 Epidural injection	9	1	2 hours, 7 minutes		1	

search before the foramina are located. Foramina are much more difficult to locate in the obese patient. Not only is the distance from the skin surface to the sacrum greater, which will of itself multiply the number of attempts necessary to locate the foramina, but it is more difficult to recognize bony landmarks. The pad of fat over the sacrum, normally more prominent in women than in men, seems to be increased in pregnancy. Often it was impossible to palpate the posterior superior spine of the ilium. For this reason some surgeons regard obesity as a contra-indication to the use of the transsacral method (Fig. 17). When, besides obesity, the parturient will not co-operate, but twists and squirms about in bed during a labor pain, transsacral nerve block becomes a tedious and aggravating procedure both to the patient and operator. Because of this difficulty, sacral nerves were next blocked by epidural injections.

The third series of 22 patients were given from 40 to 50 cubic centimeters of 1.5 per cent procaine-adrenalin solution in 0.4 per cent sodium chloride and 0.4 per cent sodium bicarbonate (Formula 3). The fourth series of 12 patients received from 25 to 35 cubic centimeters of a 2 per cent procaine-adrenalin solution with 0.4 per cent sodium bicarbonate (Formula 4). A fifth series of 12 patients was given from 40 to 50 cubic centimeters of 1.5 per cent procaine-adrenalin solution as in the third series, except that no sodium bicarbonate was employed (Formula 5). The sixth series of 10 patients were anæsthetized with a preparation of procaine and suprarenin in ampules. The ampule contains 1 gram of procain and 0.00055 gram suprarenin in 5 cubic centimeters distilled water.[1] (Formula 6). The content of this ampule added to 60 cubic centimeters of distilled water gives a soluton of 1.5 per cent strength, as in Formula 5. Two or three drops of adrenalin are added to this before use, as the normal suprarenin content is small. The advantage of such a preparation is only one of convenience in making up the solution, and in having a preparation known to be fresh.

In obtaining data as to the duration and height of anæsthesia, cutaneous sensation over the perineum was tested by means of a needle or artery forceps. Even after delivery, the patient in most cases remained in the delivery room until sensation returned. It was necessary to rely to some extent on the patient's impressions of the amount of pain experienced. This method is often inaccurate, and when utilized was obtained only during the course of an ordinary conversation, not by leading questions. Not infrequently little or no help regarding subjective sensations was obtained because of the low mentality of the patient, or her inability to cerebrate well because of fright or excitability. In such instances, and as much as possible with all patients, a careful study of behavior before and after injections was the only means of obtaining data (Table I).

It may be noted in Table I that more constant results were obtained over a longer time by the transsacral method, and that there is no advantage to be gained by the addition of sodium bicarbonate in either the transsacral or epidural methods. The difficulties in execution of transsacral nerve block already mentioned make the epidural the more practical, even though accompanied by a certain low percentage of failures and a variation in the height of anæsthesia, which we believe is due mainly to faulty technique.

Clinical course. Shortly after the injection into the sacral canal has begun, the parturient often complains of a cramping sensation or paræsthesias in the legs; this can be taken as an indication that the needle is correctly inserted. Usually within 5 minutes, depending on the rapidity with which the injections are made, a marked change in the patient's behavior is noted. The patient who previously was restless and fretful even between pains, becomes quiet during the interval, and there is not the usual

[1] These ampules were furnished through the courtesy of the H. A. Metz Laboratories.

noisy outcry. In the next few minutes, usually by the time the injection is completed, the patient becomes restful and ceases to complain at all. A rectal examination made within 5 minutes after the needle has been withdrawn reveals a marked relaxation and dilatation of the anus, as a rule, so much so that two or three digits can easily be inserted painlessly. The vaginal orifice soon begins to relax and, if a manual examination is made, the introitus will be noticeably larger. In a few instances a vagina normally admitting two fingers with difficulty, after injection admitted the whole hand. The perineum formerly firm and unyielding is now relaxed, and the levator ani is palpated with more difficulty than when normally tonic. Not long after relaxation is noted, cutaneous anæsthesia of the perineum and vulva slowly appear. In 10 to 15 minutes, the perineum is insensitive to pricking or pinching, although pressure can be identified in some cases as can traction on the skin. However, in most cases sensation of all kinds is entirely abolished.

After 2 hours the perineum usually begins to lose its anæsthesia, but sensation rarely becomes acute until after 2½ hours or more. The first change noticeable is that traction on the skin of the perineum elicits pain. Next pinching will be felt, and finally the patient will be able to distinguish between the head and point of a pin. If the child is not born during the period of anæsthesia, the pain associated with the uterine contractions gradually reappears and after from 2 to 2½ hours, the patient again begins to toss about and suffer the usual pain of labor. Relaxation is the last to disappear, often being manifest more or less for 4 or 5 hours.

The height of anæsthesia by the epidural method varied considerably. Not infrequently numbness, paresis, and paralysis of the lower extremities occurred. In a few cases this numbness continued up over the abdomen, in rare cases as high as the costal margins, giving the high sacral anæsthesia of Schlimpert and Schneider. As a rule, however, patients stated that there was numbness in the sacral region, perineum and medial surfaces of the thighs. When the transsacral method was used there was only slight involvement of the lower extremities. Usually there was numbness along the medial surfaces of the thighs, but in no case did paralysis occur. When epidural injections of 30 cubic centimeters of Formula 4 were given, involvement of the lower extremities and abdomen was more common. These manifestations were apparently in direct proportion to the size of the dose, and definitely to the rapidity with which the solutions were injected. This may possibly be explained on the basis of increased pressure forcing the anæsthetic solution higher up the extradural space, rather than permitting diffusion throughout the tissues of the sacral canal.

In the epidural method the left leg was affected more often than the right, and when both were affected, the left more markedly. In a few instances the zone of anæsthesia over the genitalia extended higher on the left side than on the right. This asymmetry was undoubtedly the result of gravity, the fluid diffusing higher on the side on which the patient lay. Paralysis of the anal sphincter was usually complete, and a word of caution is not amiss regarding the administration of enemata. They should always be given before anæsthesia is induced, for afterward there is no efficient control of the anus until the anæsthetic action has worn off. In no instance was there any loss of bladder control.

Complications. Careful watch was kept for any complications or after-effects due to the anæsthetic, and we were well pleased to observe so few. Rapid pulse and palpitation were commonly observed, the acceleration usually amounting to not more than twenty beats for each minute. This was more marked in patients exhibiting a strumous enlargement without other symptoms. In a few instances, during the injection, there was marked acceleration of the pulse, in one instance reaching 180 for a short time accompanying this was a complaint of vertigo, a feeling of faintness and precordial distress, pallor of the face, increased respiration and occasionally cold extremities. These symptoms were most always manifested during the early course of the injection and lasted but a few minutes. The injection should be stopped in such instances, then resumed slowly; the symptoms of reaction will clear up without the need of treatment. In our cases the possibility of hyperthyroidism was not ruled out, so that some of the reactions were doubtless due to hypersensitiveness to adrenalin. In no instance did a reaction last more than 10 minutes, save for a mild acceleration of the pulse.

After-effects. After-effects were few and of no consequence. Headache, which is a common sequela of spinal anæsthesia, could in no instance be linked with the anæsthetic. The incidence of headache on the day following delivery was no greater than that which occurs normally. In a few cases soreness over the sacrum was complained of for 3 or 4 days. Local tenderness was superficial at the site of injection and did not involve the bone. It was more common with the

TABLE II.—PRESENTATION, POSITION, AND OPERATIVE PROCEDURES

	Primipara	Multipara	Occipito-anterior	Persistent occipito-posterior	Breech	Face	Transverse	Operative delivery								
								Forceps			Decapitation	Version	Insertion of bag	Manual dilatation of cervix	Episiotomy‡	Lacerations†
								Low	Middle	High						
Formula 1 Transsacral method	10	6	14	1	1			2							2	5
Formula 2 Transsacral method	10	7	13	4					3					1	1	5
Formula 3 Epidural injection	13	9	15	3	3	1	1	2	3		1	2			2	4
Formula 4 Epidural injection	6	6	10	1		1		1		1					1	2
Formula 5 Epidural injection	6	7	11	2				3	2							3
Formula 6 Epidural injection	9	1	7*	2	2*			2		2		1	1	2		2
Total	54	36	70	13	6	2	1	10	8	3	1	3	1	3	6	21

†Under lacerations are included tears requiring stitches.
‡Episiotomy was not performed unless it was apparent that severe gross perineal injury was inevitable.
*Twin birth, occipito-anterior and breech.

transsacral method, or when epidural injections were repeated. This was a minor complaint, however, always clearing up within a few days without any special care.

Two patients complained of numbness of the legs, one for 3 days, and the other for 4 days. These symptoms were quickly overcome. One patient gave us concern for a few days. She complained of cold feet, pain in the back, and incontinence of urine. A low-grade temperature and a moderately accelerated pulse rate developed. Examination of a specimen of catheterized urine revealed large numbers of pus cells, and after a urinary antiseptic was given for a few days, all symptoms and findings disappeared.

It is our opinion that the procedure is relatively harmless. When compared with the after-effects of a general anæsthetic, such as ether, it has fewer disadvantages, and in addition may be used in cases in which a general anæsthetic is contra-indicated. The persistent nausea and vomiting associated with a general anæsthetic is entirely avoided.

NINETY OBSTETRIC CASES

The 90 cases comprising this study were not selected, as will be noted from the accompanying tabulations. The total number of patients delivered during this study was 162. Patients not receiving injections were missed either because they came in too late for an injection or were delivered in our absence. Fifty-four of the 90 patients were primiparæ, a percentage higher than the general average of this institution, which is about 45 per cent. This increase is due undoubtedly to the fact that the rapidity of delivery in multiparæ made it difficult to determine when to inject them, and many were delivered before they could be injected. Multiparæ were also more often admitted to the hospital just in time to be delivered.

In this series there was a considerable number of prolonged first-stage labors. There are two factors to account for this. First, because few of the parturients were seen until well advanced in labor, the only method of estimating the onset was by questioning, a method at best unreliable. Second, many of these long labors occurred in occiput posterior positions in which the use of sedatives or opiates was avoided in order not to introduce any complicating factors. The result was an increase in the incidence of secondary inertia, and undoubtedly some of the forceps deliveries could have been avoided if rest periods had been given. Such facts must be considered in an analysis of these cases from the standpoint of the incidence of the use of forceps and of inertia. In two instances the second stage was allowed to prolong itself for an unusual length of time in order to determine whether the anæsthetic was the cause of the inertia; in neither case could it be attributed to the anæsthetic.

Fifty-one per cent of the patients were colored women, which is about the normal percentage for this hospital. The large number of colored patients naturally increases the frequency of prolonged labor due to contracted pelves. The average weight of the newborn was 7 pounds, as compared with 7 pounds and 3 ounces, the average weight in the cases delivered without the injections. The slight difference may be accounted for by the higher percentage of primiparæ in the series. The high incidence of colored patients also lowers the average weight somewhat.

VALUE IN OPERATIVE OBSTETRICS

It is obvious that all the operations and manipulations in which the operative field lies within the area innervated by sacral nerves can be painlessly performed under sacral nerve block anæsthesia (Table II). Its use in this field possesses many distinct advantages. The unmistakable relaxation of the pelvic floor facilitates any operation attempted by way of the genital tract.

Twenty-one forceps operations were performed, of which ten were low forceps, eight mid-forceps, and three high forceps deliveries. In only three instances was any other anæsthetic employed. Ether was given to one of the patients for psychic reasons only, only enough being given to keep the patient mentally confused. In another instance the patient was given a general anæsthetic before the possibilities of block anæsthesia in this type of work were appreciated. This forceps operation could undoubtedly have been performed without the use of a general anæsthetic. In the third case, general anæsthesia was necessary because the nerve block anæsthesia began to wear off before the forceps delivery was complete. Ether was used in the decapitation operation for the same reason.

The advantages of sacral nerve block anæsthesia in forceps operations are numerous. One can obtain the maximum of perineal relaxation, which facilitates the process of applying the blades, and therefore shortens the duration of the operation and reduces the number of perineal tears. The patient continues to have good uterine contractions unless operated upon immediately after the injections, and the operator not only can apply traction during each contraction of the uterus, but can also induce the patient to co-operate by bringing her abdominal muscles into action. Another strong argument for this method is the absence of harm to the baby from the anæsthetic. In difficult forceps cases, the operator is often hurried because of the danger of anæsthetizing the child. But by this method no worry need be felt so far as the anæsthesia is concerned, and it is not necessary to hurry, with consequent danger of injury to maternal parts.

So far as the mother is concerned, the operation is painless. Occasionally the patient feels pressure as the head is born, but no true pain. The patient's attention is usually engaged by conversation with an assistant who also sponges the patient's face, administers small sips of water, or in other ways obtains control of her attention, and instructs her to bear down as desired. Many of the operations were done immediately after injection, a few at the end of 2 hours, and one after 3 hours. In three instances the Scanzonian manœuvre was performed for persistent occiput posterior positions. In other instances the head was delivered posteriorly, because the relaxation was such that it was deemed unnecessary to rotate. The three high forceps operations were performed very slowly, one taking an hour, and it was exceedingly satisfactory not to be worried about the possible effects of ether on the baby.

There is little difficulty in formulating an opinion with regard to the advisability of using sacral anæsthesia in forceps operations, for there is only one real disadvantage to be considered. In cases in which the indication for operation is fetal exhaustion, the sacral procedure might be too slow. Other than that, the only arguments against its use are those that apply in general surgery, principally the factor of consciousness, which many surgeons demand shall be abolished before beginning any operation of magnitude.

The operation of version and extraction may also be painlessly performed, the relaxation of the pelvic floor being advantageous for this operation. The indications for this procedure were very few in our series, being performed only three times. In such cases it was necessary to obtain the co-operation of the patient in relaxation of the abdominal walls, and too much pressure on the abdomen may result in pain. Some may question the advisability of using this anæsthesia for version, but when it is understood that for a few minutes immediately following the injection the uterine contractions are greatly diminished and not infrequently stopped, so far as can be determined by palpation, this objection carries less weight. In the three instances in which version and extraction were performed, the version was performed immediately after the injection, the patients having been prepared for operation before the injections were made. In this way the turning could be done while the uterus was more or less atonic, and in each case no difficulty was experienced because of the contracting organ. In two cases this measure was used to quiet the uterus until instruments could be made ready for operation. One was a patient having terrific uterine contractions, with the cervix not completely dilated, and the head in the middle pelvic position. Because of a small pelvis and a history of a previous cæsarean section, a middle forceps operation was performed following manual dilatation of the cervix. The other case was that of a neglected transverse, with violent uterine contractions and membranes long since ruptured. Following injection, the uterus became quiet for a few moments until preparations for a decapitation could be made.

Breech presentations can be admirably handled by this method of anæsthesia, for the relaxation of the perineum not only shortens the birth of the breech because of diminished muscular resistance, but facilitates the manipulations so often necessary to deliver the arms and aftercoming head. Relaxation was so great in the six breech cases in this series as well as in the extractions following

the three versions, that episiotomy, so often necessary in these cases, was not performed. One case was particularly worthy of more detail. A first born baby, 9 pounds and 8 ounces in weight, was delivered without the least necessity of an episiotomy, and no demonstrable laceration of the vaginal mucosa or perineum could be found.

Repair of perineal tears was painlessly performed eighteen times, and of cervical tears once. Episiotomy and repair were painlessly performed five times. The anæsthesia has also been used in removing uterine contents in incomplete abortions, in inserting the Voorhees bag and in uterine packs, in patients not included in this list. We were anxious to try the method in vaginal hysterotomy, but the opportunity was lacking.

It was hoped in the beginning that, in cases of rigid cervices, this anæsthesia might relax the cervix and thus shorten the duration of labor. To reach definite conclusions regarding such an occurrence was extremely difficult, as there were so many factors to be considered. Many cases were studied with reference to softening of the cervix, and the injection was given in several instances with this object in mind. Certain patients were definitely improved following injections, but a few were not improved. A conservative opinion is that, in the treatment of a rigid cervix, this procedure cannot be depended on, and we would hesitate to advise its use for that alone. The few cases in which it was combined with scopolamine and morphine showed more favorable results, but it is not impossible that the latter is the chief factor. Further studies should be conducted on this point before a definite statement is made.

In one case, because of a delay during the first stage of labor, evidently caused by a rigid cervix, it was decided to dilate the cervix manually and do a version and extraction in order to expedite delivery, as the patient was a primipara in poor general condition due to a nephritic toxæmia. The cervix, at the time the operation was begun was dilated sufficiently barely to admit the tips of two fingers. Manual dilatation was performed easily and slowly. In two other instances manual dilatation preparatory to operative interference was done with marked ease. The evidence in these cases seems to speak for a partial relaxation of the cervix following injection. The intense pain usually associated with dilatation of the cervix was absolutely wanting.

VALUE IN NORMAL DELIVERY

The value of this means of anæsthesia in spontaneous delivery will, of course, depend on its influence on the progress of labor. Whenever a method of relieving the pains of labor retards or stops the progress of birth, it must be employed with caution. This drawback will obtain to a certain degree with all methods of anæsthesia, because there is usually a direct relation between the amount of pain in labor and the rapidity of progress. In the early course of labor, the pains are the result of the uterine contractions, first in effacing, then in dilating the cervical canal. Later, pain is produced by the distention of the pelvic floor, causing the act of bearing down. The parturient bears down the harder as the pains increase in intensity, finally causing the act of bearing down to become entirely involuntary. Pain, therefore, normally serves as the regulating mechanism for the necessary increase in the intensity of the expulsive powers. If this influence is not experienced throughout the course of labor, it must be compensated for by other means. This fact was not realized in our earlier cases, several of which were allowed to procrastinate until the anæsthesia had subsided. Much better progress was noted after we began instructing the patient how to bear down, and urging her to greater voluntary effort during the uterine contractions. In the absence of proper instruction and encouragement, the parturient is likely to rest and delay the progress of birth until the pains are again felt. It is, therefore, paramount that the continual attendance and encouragement on the part of the obstetrician or attendants be maintained at this juncture.

In the majority of the patients receiving epidural injections and in a few injected by the transsacral method there was nearly complete cessation of the uterine contractions within 10 minutes after the operation was completed. This was also more complete and probably somewhat prolonged in patients receiving the sodium bicarbonate solution. This diminution rarely lasted more than 20 minutes, after which the contractions gradually increased in frequency and duration until shortly the contractions proceeded normally. Unless the abdomen was palpated, however, one would not know whether the contractions were continuing or not. This has not infrequently led the casual observer, as well as the patient, to believe that labor has ceased. Because of the comparatively sudden transition from a condition of extreme anguish to one of ease, there was a tendency to rest or doze in comfort. Feeling no pain, it was difficult for the patients to appreciate the fact that they were in labor, and to realize the necessity of voluntary bearing down in order that labor might progress.

TABLE III.—DURATION OF LABOR AND WEIGHTS OF INFANTS

	Average duration of labor						Weight of infants in grams		
	First stage		Second stage		Third stage				
	Primipara†	Multipara	Primipara	Multipara	Primipara	Multipara	Average	Low	High
Formula 1 Transsacral method	18 hours	8 hours 8 minutes	1 hour 24 minutes	52 minutes	13 minutes	11 minutes	3480	2400	4560
Formula 2 Transsacral method	21 hours 45 minutes	9 hours 42 minutes	1 hour 45 minutes	48 minutes	12 minutes	16 minutes	3750	2760	4440
Formula 3 Epidural injection	13 hours 30 minutes	7 hours 35 minutes	2 hours 35 minutes	48 minutes	10 minutes	12 minutes	3360	1980	4290
Formula 4 Epidural injection	25 hours	10 hours 20 minutes	1 hour 30 minutes	50 minutes	11 minutes	22 minutes	3330	2310	4320
Formula 5 Epidural injection	13 hours 25 minutes	14 hours 24 minutes	2 hours	43 minutes	15 minutes	9 minutes	3330	2460	4185
Formula 6 Epidural injection	19 hours 24 minutes	5 hours*	2 hours 12 minutes	45 minutes*	18 minutes	15 minutes*	3000	2220	3840

†The first stage durations are not very reliable since they were estimated in most cases from the patients' statements which are often far from reliable. Another factor increasing the duration of the first stage is the high incidence of pathological lesions which is usual at charity hospitals.
*1 multipara only in this series.

This is undoubtedly what occurred in the observations of Schlimpert and Schneider. A few continued to have abdominal pain of colic-like type and a few a feeling of tension in the region of the broad ligaments during contractions, but such pain is usually of a mild nature. In two instances the presenting head definitely retreated following injection. The only explanation we can offer is that the pelves of these patients were moderately funnel-shaped and that during the preliminary diminution in contractions the passengers slipped back. In both instances the anæsthesia was given early in labor.

The feature of greatest difficulty is in the selection of the proper time to induce anæsthesia. There was a tendency to apply it too early in primiparæ and too late in multiparæ. At first a considerable number received injections too early to obtain the benefits of the anæsthesia during the actual expulsion, because of our mistaken impressions about the duration of anæsthesia. In many cases, also, the time of delivery could not be accurately foretold. However, it was soon found that the injections could be repeated without apparent danger, so that a second, and in three cases a third injection, was given when there had been little or no reaction from the first one. Yet we feel that the injections should not be unnecessarily repeated. Ability to judge the proper time for injection is absolutely essential if the best results are to be obtained, hence the necessity of having the patient under close surveillance and of having knowledge of position, dilatation, station, and progress. Any abnormalities that may retard the normal progress must be taken into consideration when estimating the proper time for anæsthesia. The duration of anæsthesia in our cases averaged only 2 to 2½ hours, so that the problem is to select the time which lies within the last 2-hour period, including the termination of labor. If it could be determined with certainty that labor would terminate within an hour, the problem of sacral nerve block anæsthesia would be much more easily solved. At first, injections were given when the dilatation of the external os was 4 or 5 centimeters and the head at or below the ischial spines in primiparæ. Multiparæ were injected at about the same time. Later it was decided that the best time for primiparæ was at a somewhat later period, when the os had reached at least 7 centimeter dilatation, and in multiparæ when the dilatation was at least 4 centimeters for average cases.

When, as a result of good co-operation on the part of the patient, labor terminates during the period of anæsthesia, it will be without the usual outcry, and often the patient will not believe the baby has been born until it is shown to her. Other patients feel dull pressure as the head slips over the perineum. The perineum slides back readily from the head in most instances with such ease that often the obstetrician is surprised, because a tear seems inevitable. In a few in-

stances an episiotomy was performed because of marked narrowness of the introitus. Following delivery, no tendency to atonicity of the uterus was noticed. The placenta separated normally, and there was no tendency toward hæmorrhage, so far as could be estimated grossly. In fact there was less blood lost and less atonicity than when ether was administered at the completion of the second stage. Involution of the uterus occurred normally, and late postpartum hæmorrhage did not develop. In none of the cases was there any alarming hæmorrhage following expulsion of the placenta.

The fact that the parturient did not lose consciousness enabled her to appreciate the progress of labor, step by step, until termination occurred. Under these conditions, the opinion of the patient was of great value and it was within the power of the obstetrician and others to impress her with the advantage of this procedure. Most patients who had experienced previous labors without anæsthesia expressed profound appreciation of the freedom from pain of the present method. Not infrequently, after the study had been well started patients came to the delivery rooms with the request that the injections be given them, as they had heard how easy it was to have babies by this method of anæsthesia. We had no difficulty in obtaining the consent of the patient, and particularly when it was desired to repeat the injection. One of the investigators was accosted one day by the occupant of an apartment over the maternity department with the question, "Aren't you having any deliveries down stairs anymore?" This emphasizes the infrequency of the usual noises emanating from the delivery room. This feature was frequently remarked on by the nurses in attendance, and lately one of us has received a communication from that department of the hospital stating that the noise and commotion following the completion of this study was not only much more noticeable, but annoying.

DISCUSSION

While the period of most extreme anguish in spontaneous delivery may be controlled by present methods of block anæsthesia, the field of usefulness will greatly increase when a means has been devised to prolong the action of an epidural injection. Of the many methods devised to potentiate local anæsthetic solutions, the addition of sodium bicarbonate had been given widest publicity, and this method in our hands was of no value at all. Other chemicals have been used, such as calcium chloride, and potassium sulphate. Clinical experience, however, indicates that the potentiation attributed to these drugs is greatly overestimated. Allen suggests the addition of 5 per cent gelatin to the solution to delay absorption from the point of injection and thus increase its efficiency. This method would seem to possess advantages and should be given a thorough trial in obstetrics.

Of all local anæsthetic substances, the duration of anæsthesia is longest with quinine and urea hydrochloride solutions. Anæsthesia may last from several hours to 5 or 6 days in infiltration anæsthesia. The injection of a solution stronger than 0.25 per cent produces a marked induration of tissues which may end in sloughing. This induration is due principally to a fibrinous exudate, indicating a local irritant action on tissues. For this reason its use has been largely abandoned in infiltration anæsthesia, and it was never popular for nerve trunk anæsthesia. No record of its use in epidural injections is available, but because of the local tissue disturbance within the sacral canal that a solution of sufficient strength to block sacral nerves would most likely produce, its use here is not to be recommended. A small amount of this drug, 0.1 to 0.2 per cent, is still occasionally added to other local anæsthetic solutions for the purpose of prolonging the anæsthesia. This strength might prove harmless in the sacral canal when added to the usual novocaine formula, and of real advantage in prolonging the duration of anæsthesia.

Further investigation should be made of the whole subject of epidural injections as applied to obstetrics. It is possible that the drugs are already at hand which, by their proper combination and use, will produce a perfectly safe local anæsthesia of the entire pelvic floor and viscera for 5 or 6 hours without repetition. Such a procedure should find immediate widespread use in obstetrics and prove to be the anæsthetic of choice in normal delivery.

SUMMARY

Special care should be exercised in utilizing every possible detail contributing to the physical comfort and mental ease of women while on the operating table. Such precautions are especially valuable with regard to the lithotomy position, which is at best uncomfortable, sometimes exceeding the limit of tolerance in obese women.

The preliminary administration of pantopon and scopolamine in proper amount contributes in establishing favorable conditions, but the stage of twilight sleep should not be reached.

The more superficial operations on the vulva, perineum, and anus may be quite satisfactorily

performed under terminal infiltration. Such operations include the removal of cysts and solid benign tumors of the labia majora and minora, superficial fistulæ, perineorrhaphy, surgery of the terminal rectum, and the removal of cervical polypi.

The foregoing operations may be painlessly performed in by far the greater number of cases by block of the sacral nerves by injection of an anæsthetic medium into the sacral canal, called epidural, sacral, extradural, and caudal anæsthesia. If one who uses this method is willing to supplement the failures by local infiltration, it does not work so much of a hardship. The height of anæsthesia by this method is variable, although in a majority of cases anæsthesia of the entire pelvic floor and viscera is produced. Its chief use, in addition to the more superficial operations on the external genitalia, perineum, and terminal rectum, is in dilatation and curettage and in urologic manipulative work.

For the deeper operations on the pelvic floor and viscera the local anæsthetic procedure of choice is the association of a low epidural injection with transsacral block of the upper four sacral nerves. This procedure gives a uniformly satisfactory anæsthesia in surgery of the pelvic floor and viscera by the perineal route. It has been found sufficient for posterior resections of the carcinomatous rectum, both the single and second stage resections, the posterior wall of the vagina often being removed with the growth. Excision of multiple perineal fistulæ and malignant growths of the vulva and vagina, perineorrphaphy, anterior colporrhaphy, repair of vesicovaginal and rectovaginal fistulæ vaginectomy, amputation of the cervix, the Watkin's interposition operation, vaginal hysterectomy, and excision of the carcinomatous urethra, have been painlessly performed under this anæsthesia. Resection of the bladder may be painlessly performed when field block is added for the suprapubic incision.

The borderline of usefulness of the transsacral method is seen in the posterior resection of a high lying carcinoma of the rectum, or rectosigmoid, the Watkins interposition operation, and the Mayo vaginal hysterectomy. Here the traction necessary in delivering the viscus into the operative field is often transmitted outside of the anæsthetized area and produces pain. This traction pain cannot be controlled by paravertebral nerve block, but, when it is necessary, a short primary ether narcosis, or nitrous-oxide-oxygen analgesia should be administered at this point.

Parametric injections do not efficiently control the traction pain of surgical manipulation in vaginal hysterectomy, and anæsthesia of the vagina, also, is usually necessary.

Local anæsthesia in pelvic operations by the abdominal route is sufficient for the laparotomy, but general narcosis is usually necessary for the pelvic work. For most surgeons of wide experience, local anæsthesia, by whatever method induced, does not create an operative condition compatible with the employment of the surgical methods indicated by most pathologic conditions of the pelvis.

In obstetrics the epidural method is more practical than the transsacral, although block of the lower four sacral nerves by the latter technic with the aid of a low epidural injection, gives satisfactory anæsthesia. A great advantage of the method is the relaxation of the pelvic floor, which is more complete than with any other anæsthesia.

The forceps operation, version and extraction, manual dilatation of the cervix, rotation and repair of cervical and perineal tears may all be painlessly performed by epidural anæsthesia, which may also be used in the removal of uterine contents in incomplete abortions, packing of the uterus, and in insertion of the colpeurynter.

The pains of normal labor may be controlled by this method, although the abolition of the pain reflex also takes away the voluntary effort of bearing down. Uterine contractions continue, however, so that if the parturient is instructed when and how to bear down, completion of labor occurs painlessly.

The feature of greatest difficulty is in the selection of the proper time to induce anæsthesia. Most cases could be made to terminate painlessly if the anæsthesia could be administered an hour to an hour and a half before delivery. In our experience, the maximal value of the anæsthesia results when not given until the os has reached at least 7 centimeters dilatation in primiparæ and at least 4 centimeters in multiparæ for average cases.

The field of usefulness in spontaneous delivery will greatly increase when a means has been devised to prolong the action of an epidural injection. Further investigation is necessary on this subject. It is possible that the drugs are already at hand, the proper combination and use of which will anæsthetize the entire pelvic floor and viscera for 5 or 6 hours without repetition. Such an anæsthetic should prove a great blessing in obstetrics and become the anæsthetic of choice in normal delivery.

BIBLIOGRAPHY

1. ALLEN, C. W. Local and Regional Anæsthesia. 2d ed. Philadelphia: Saunders 1918, 486-493.
2. AMBROSINI. L'anestesia sacrale. Ann. di. ostet., 1912, i, 492-513.
3. BRAUN, H. Oertliche Betaeubung. 5th ed. Leipzig: Barth, 1919, 375-380.
4. IDEM. Die Grenzen der oertlichen Betaeubung in der Chirurgie. Deutsche med. Wchnschr., 1922, xlviii, 151-153.
5. CABOT, H. Subarachnoid (spinal) anæsthesia. Keen's Surgery. Philadelphia: Saunders, viii, 860-867.
6. CORNING, J. L. Spinal anæsthesia and local medication of the cord. New York M. J., 1885, xlii, 483-485.
7. CRENSHAW, J. L. The treatment of urethral caruncle. Minnesota Med., 1920, iii, 54-57.
8. DAVID, V. C. Local anæsthesia for hæmorrhoidectomy. Surg. Clin. Chicago, 1917, i, 543-552.
9. DANIS, R. L'anésthesie régionale. Brussels: Hayez, 1913, 32-38.
10. DELEE, J. B. Textbook of Obstetrics. 3d ed. Philadelphia: Saunders, 1918, 303-308.
11. EDGAR, J. C. The Practice of Obstetrics Designed for the Use of Students and Practitioners of Medicine. 5th ed. Philadelphia: Blakiston, 1916, 835-843.
12. FARR. Vaginal and vaginopelvic operations under local anæsthesia. Interstate M. J., 1917, xxiv 660-668.
13. FERREYRA, F. La analgesia obstetrica por inyecciones epidurales de novocaina. Crón. méd., 1916, xxxiii, 136-143.
14. GROS, O. Ueber eine Methode die Anaesthesierende Wirkung der Lokalanaesthetika zu steigern. Muenchen. med. Wchnschr., 1910, lvii, 2042-2044.
15. HARRIS, M. L. Nerve blocking. Surg., Gynec. & Obst., 1915, xx, 193-197.
16. HERTZLER, W. E. Surgical Operations with Local Anæsthesia. 2d ed. New York: Surgery Publishing Co., 1916, 208-214.
17. HOAG, C. L. The application of anociassociation to obstetrics. Surg., Gynec. & Obst., 1916, xxiii, 612-614.
18. HUGGINS, H. R. Spinal anæsthesia in obstetrics, gynecology, and abdominal surgery. Am. J. Obst. & Gynec., 1922, iii, 412-418.
19. ILMER. Ueber Pudendus Anaesthesie. Zentralbl. f. Gynaek., 1910, xxxiv, 699-702.
20. KEHRER, E. Erfahrungen ueber Sakralanaesthesie besonders bei gynaekologischen Operationen. Monatschr. f. Geburtsh. u. Gynaek., 1915, xlii, 95-138.
21. DE KERVILY, M. Sur l'anésthesie par les injections epidurales dans l'accouchement. Presse méd., 1912, xx, 789-790.
22. KING. Surg., Gynec., & Obst., 1916, xxiii, 615-618.
23. LABAT, G. L. Posterior resection of the rectum and rectosigmoid (Kraske or modified) under regional anæsthesia. Bull. Johns Hopkins Hosp., 1922, xxxiii, 134–140.
24. IDEM. Regional Anæsthesia. Philadelphia: Saunders, 1922, 251–286; 400–422.
25. LAEWEN, A. Ueber die Verwendung des Novokains in Natriumbicarbonat Kochsalzl'oesungen zur lokalen Anaesthesie. Muenchen. med. Wchnschr., 1910, lvii, 2044–2046.
26. IDEM. Ueber die Verwertung der Sakralanaesthesie fuer chirurgische Operationen. Zentralbl. f. Chir., 1910, xxxvii, 708–711.
27. MARTINS, H. Die Lokalanaesthesie bei vaginalen Operationen. Med. Klin., 1920, i, 5–7.
28. MEEKER, W. R., and FRAZER, E. B. Transsacral nerve block anæsthesia in surgery of the pelvic floor and viscera. Surg., Gynec. & Obst., 1922, xxxv, 801–812.
29. MEEKER, W. R. The use of paravertebral nerve block anæsthesia in general surgery. Minnesota Med., 1923, vi, 138–152.
30. PAUCHET, V. Spinal anæsthesia. Am. J. Surg., 1920, xxxiv, 1–5.
31. PERRILL, I. Sacral anæsthesia. Illinois M. J., 1920, xxxviii, 236–239.
32. PIANTONI, G. L'anestesia epidurale specialmente en riguardo al parte spontaneo. Riv. osp., 1913, iii, 986–1000.
33. RUGE, E. Lokalanaesthesie in der Gynaekologie; vaginale Totalexstirpation des Uterus in Leitungsanaesthesie. Zentralbl. f. Gynaek., 1912, xxxvi, 561–565.
34. IDEM. Erfahrungen in den 22 ersten Faellen von vaginalen Operationen in parametraner Leitungsanaesthesie. Muenchen. med. Wchnschr., 1914, ii, 2401–2403.
35. SCHELLEKENS. Painless childbirth. Nederl. Tijdschr. v. Geneesk., 1921, ii, 2060.
36. SCHLIMPERT and SCHNEIDER. Sakralanaesthesie in der Gynaekologie und Geburtshilfe. Muenchen. med. Wchnschr., 1910, lvii, 2561–2565.
37. SCHLIMPERT. Ueber hohe extradurale Anaesthesie. Deutsche med. Wchnschr., 1911, xxxvii, 719.
38. SCHOLL, A. J. Sacral anæsthesia in urology. J. Urol., 1921, vi, 149–171.
39. SMITH, G. G., and PORTER, W. T. Spinal anæsthesia in the cat. Am. J. Physiol., 1915, xxxviii, 108–127.
40. STOCKEL, W. Ueber sakrale Anaesthesie. Zentralbl. f. Gynaek., 1909, xxxiii, 1–15.
41. TOELKEN, R Erfahrungen mit der parasakralen Anaesthesie. Deutsche med. Wchnschr., 1914, i, 174–176.
42. WILLIAMS, J. W. Obstetrics. 4th ed. New York: Appleton, 1917, 236–251; 343–349.

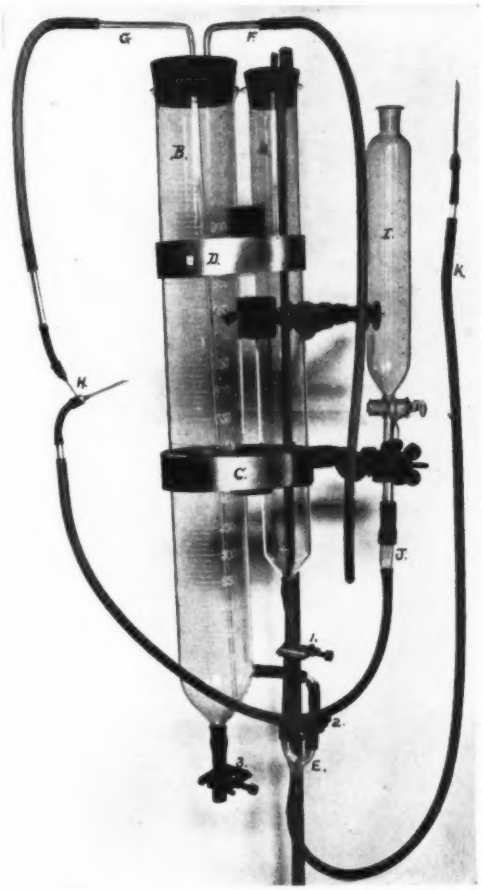
NEW APPARATUS FOR BLOOD TRANSFUSION WITH THE CITRATE METHOD

By GEORGE E. COWLES, M.D., and HENRY W. ANTZ, New Haven, Connecticut
From the Department of Obstetrics and Gynecology, School of Medicine, Yale University

DURING the last few years there has been a notable increase in the use of blood transfusion, not only as a therapeutic measure in secondary anæmias, but especially in the treatment of severe infections, as puerperal septicæmia and thrombophlebitis subsequent to labor. In spite of numerous attempts to modify the direct method of transfusion, the indirect or citrate, method is the simplest and yields very satisfactory results. In the Woman's Clinic at Yale University, the latter method is frequently employed and the apparatus which we have devised so facilitates the procedure that commonly little more work is required than in giving an ordinary hypodermoclysis.

The apparatus illustrated consists of two cylinders: The smaller *A* is an ordinary 300 cubic centimeter infusion tube. The larger *B* is an especially designed 1000 cubic centimeter tube, 6.5 centimeters in diameter. These tubes are held together by two bands of aluminum (*C* and *D*) and are connected below by rubber tubing and a Y-tube of glass, as shown at *E*. Tube *A* is closed by a rubber stopper through which a small glass tube passes. Tube *B* is closed above by a rubber stopper perforated by two pieces of glass tubing. One of these, *F* is to allow for suction; to the second, *G*, is attached a short length of rubber tubing which connects with the needle to the donor. It is important that the second glass tube, *G*, reaches nearly to the bottom of the cylinder in order to prevent splashing and the subsequent coagulation of the blood. The glass and rubber tubing through which the blood flows from the donor should be of small diameter. In the apparatus in question, tubing 5 millimeters in diameter is employed. The donor's needle, *H*, is No. 15 gauge and 1½ inches in length. Into the base of this is soldered a No. 19 or No. 20 gauge needle. Rubber tubing connects the latter with the graduated separatory funnel, *I*. At *J* is a glass window through which it is possible to see any solution flowing from the end of the separatory funnel. By counting the number of drops per minute the rate of flow is readily measured.

The transfusion is carried out as follows: Approximately 100 cubic centimeters of sterile saline solution is put into the small cylinder. The three pinch cocks, *1*, *2*, and *3*, are opened and a small amount of salt solution is allowed to flow into the large cylinder, thereby filling the rubber connecting tubes with saline. Now pinch cocks *1* and *2* between the cylinders are closed; and after the saline solution that has collected in the bottom of the large cylinder has run out, pinch cock *3* is closed. The separatory funnel, held in a convenient position by a clamp on the stand, is filled by a 2 per cent sodium citrate solution. Approxi-



mately 15 cubic centimeters of the latter solution is now allowed to flow through the rubber tubing and donor's needle into the large cylinder *B*. In this way the entire system of tubing is citrated before the collection of blood begins.

After preparing the donor's arm with tincture of iodine and alcohol, the needle is inserted into a prominent vein at the elbow. When blood enters the needle the stop cock of the separatory funnel is so adjusted that the rate of flow of the citrate solution is approximately 2 drops per second. Naturally the rate varies, depending upon the rate of the blood flow, but the final mixture represents 15 cubic centimeters of citrate solution to every 100 cubic centimeters of blood. To give the blood to the recipient the long rubber tubing *K*, with its glass window, is removed from the hole in the rubber stopper between the upper ends of the two cylinders and, depending upon the size of the recipient's vein, connected to a No. 16 or No. 18 gauge needle. After the tube and needle have been filled with saline, the flow is temporarily arrested by pinching the tube with the fingers, and the needle is inserted into the recipient's vein. The pressure upon the tubing is then released and the apparatus lowered below the arm so that a negative pressure is established in the needle. As soon as the blood flows from the vein into the needle, the colored saline solution can be seen through the glass window. The tourniquet previously wound about the arm is now released and the apparatus is elevated. When the flow of saline is well established, the solution is shut off by closing pinch cock *1*. Pinch cock *2* is now opened and the blood in *B* is allowed to flow slowly into the recipient's veins. If clots should form, they will settle to the bottom of cylinder *B*, and will not pass over into the rubber tubing. If the transfusion proceeds too slowly or if the needle is pulled out of the vein, the blood can be shut off by closing pinch cock *2*, and the tube and needle can be flushed out by opening pinch cock *1*. The latter factors have so facilitated the procedure that when the apparatus has been employed it has been necessary to expose the recipient's veins only when they were unusually small or collapsed subsequent to a severe hæmorrhage.

The observations of Clough, DeKruif, Drinker and Brittingham, Hartman, Satterlee and Hooker, and others confirm our experience that incipient coagulative changes play an important part in causing chills following transfusions. Citration within the needle is the most logical procedure to avoid these changes. We have found that the method described not only eliminates all clot formation but materially decreases the number and severity of the chills subsequent to the intravenous administration of blood.

ADVANTAGES

The chief advantages of the apparatus are:

1. Saline solution is always available.
2. The blood is citrated within the donor's needle, thereby avoiding as much as possible incipient coagulation changes.
3. A closed method for transfusion is provided which eliminates the necessity of transferring blood from one container to another.
4. The apparatus is simple and is easily manipulated, and when it is employed the assistance of but one person is necessary.

REFERENCES

1. Clough and Clough. A study of the reactions following the transfusion of blood. South. M.J., 1921, xiv, 104–109.
2. DeKruif. Toxicity of normal serum. J. Infect. Dis., 1917, xx, 717–775.
3. Drinker and Brittingham. The cause of reactions following the transfusion of citrated blood. Arch. Int. Med., 1919, xxiii, 133–149.
4. Hartman. Transfusion reactions and citration within the needle. J. Am. M. Ass., 1922, lxxviii, 15–17.
5. Satterlee and Hooker. Transfusion of blood with special reference to the use of anti-coagulants. J Am. M. Ass., 1916, lxvi, 618, 624.

THE TREATMENT OF PRURITUS VULVÆ[1]

By SOLOMON WIENER, M.D., F.A.C.S., New York
Associate Gynecologist, Mount Sinai Hospital

IN a sense pruritis vulvæ is a symptom and not a disease. Yet there are many cases in which it persists *per se* without any concomitant symptoms, or discoverable etiological factors, and attains the dignity of a clinical entity.

The intense suffering to which it may give rise is well known. Indeed, in extreme instances it may make life wellnigh insufferable for its victims. There has been much discussion as to whether this pruritus is a local disease or a neurosis. In any event, there is an irritation of the vulvar nerve endings interpreted as itching. This in turn brings on the impulse to scratch, and so a vicious circle is established, which persists long after a leucorrhœal discharge, or other etiological factor, has ceased to operate.

The treatment of this condition has been notoriously unsatisfactory. Indeed, the multiplicity of remedies employed bespeaks their futility. Of course, where there is a distinct etiological factor, such as a leucorrhœal discharge, diabetes, or a local eczema which is part of a generalized eczematous tendency, the treatment must be that of the causative factor. Such cases usually improve readily when the underlying cause is removed.

Excluding all such cases, there still remains a group in which the pruritus presents itself as an essential condition. This usually occurs in women close to, or past, the menopause. The vulva is more or less atrophic, the skin is infiltrated, and has often a greyish-red, somewhat glazed appearance. In long standing cases there are added the secondary changes induced by scratching and consequent infection.

It is in this class of apparently essential cases that I have been using what I believe to be a new treatment for this condition. It is based upon the belief that the itching is due to an irritation of the nerve endings, and that the consequent scratching gives rise to a vicious circle of cause and effect which must be broken into to effect a cure. The treatment consists in repeated infiltrations of the vulva with a non-toxic local anæsthetic. The principle is, of course, not new. Many forms of irritation of sensory nerve endings, interpreted as pain, have been treated heretofore by infiltration of the nerve trunk or nerve endings.

The technique employed is very simple. The skin and subcutaneous tissue along the outer border of the labia majora are continuously infiltrated with a 1 per cent solution of novocain. Eight cubic centimeters are used at one sitting, 4 cubic centimeters being injected on either side of the vulva.

No curative effect is attributed to the novocain. Its purpose is merely to render the infiltration itself painless. The curative action is attributed rather to the mechanical effect of the infiltration, and could doubtless be achieved, though in a less painless way, with salt solution.

All cases have been readily treated in the out-patient department. The injections have been repeated at intervals of a week. No case has received more than five injections; in some patients from one to three have sufficed.

The results have been distinctly encouraging. It is too early to report final statistical results; that is not the object of this preliminary report. There have been a few cases that must be classed as failures. The majority have been vastly improved, and in such a way as cannot be attributed to an ephemeral effect of the novocain. About half the cases have been definitely cured. That is to say, they have been symptom-free for prolonged periods, after having suffered for months or years before this treatment was instituted.

In view of the very unsatisfactory results hitherto obtained in the treatment of pruritus vulvæ, the author feels that this method is worthy of a trial by others. The number of cases of "essential" pruritus occurring on even a large out-patient service is small. In order to give this method a trial in a sufficient number of cases to properly evaluate it, it will be necessary to employ it in more than one clinic. In this connection it must be emphasized again that cases with leucorrhœal discharge, diabetes, or general eczema must receive treatment appropriate to those conditions. It is only in the "essential" cases that this treatment should be tried. Obviously it is useless to attempt a cure when such an active causative factor is present.

Some of our successful cases showed little or no improvement after one or two treatments. It is not sufficient to stop the injections at this point; they must be persisted in for a number of weeks. When a series of four or five injections does not bring about any improvement, the treatment is of no avail. As a rule there is a temporary improve-

[1] From the gynecologic service (Dr. Joseph Brettauer) at Mount Sinai Hospital.

ment after each injection, and then a recurrence which becomes less and less marked after each treatment.

A summary of seven successful cases follows.

CASE 1. Dispensary No. 2860. A. C., age 58. June 26, 1922. Florid type of complexion; dry eczema of thighs and buttocks; vulva atrophic with excoriations from scratching. Intense pruritus vulvæ for 1 year. Novocain injection given. July 3, 1922, condition much improved; only slight itching persists. Second novocain injection, July 17, 1922. Itching has ceased after two injections.

CASE 2. Dispensary No. 1439. A. M., age 62. Patient wears a pessary for prolapse. Severe pruritus for 3 weeks. Vulva atrophic, otherwise negative. April 29, 1922, novocain injection. June 16, 1922, itching has ceased. December 21, 1922, patient remains symptom-free after 8 months.

CASE 3. Dispensary No. 453. R. G., age 48. May 9, 1922. Pruritus of 8 months' duration. Vulva has a greyish glazed appearance. Novocain injection, May 16, 1922. Complete relief for 4 days; itching has now returned. Novocain injection, May 23, 1922. Itching has ceased. Now complains of irritation of clitoris. Ten per cent silver nitrate applied to clitoris. May 29, 1922. No further itching. Irritation of clitoris improved. June 5, 1922. Intense itching since yesterday. Novocain injection. June 26, 1922. Itching was relieved for some time, now has returned. Novocain injection. July 10, 1922. Occasional slight itching but not daily. February 1, 1923. Has been free from itching for over 6 months; vulva has resumed a normal appearance.

This case was cured by a series of four injections extending over a period of 6 weeks.

CASE 4. Dispensary No. 5174. M. R., age 50. January 23, 1923. Severe pruritus for 2 years. Vulva red and glazed, excoriated, infiltrated. Novocain injection, January 30, 1923. Pruritus has ceased; some itching of inner surface of thighs, where there is eczema. February 7, 1923. No further itching of vulva. Eczema of thighs improving under ointment. This case was lost from further observation; a pruritus of 2 years' standing appears to have been relieved by a single injection.

CASE 5. Dispensary No. 3776. M. T., age 44. June 9, 1922. Pruritus vulvæ for several months; vulva atrophic, shows scratch marks. Novocain injection, June 16, 1922. No improvement. Novocain injection, June 23, 1923. Much improved. January 6, 1923. Has remained well for 6 months, except for occasional slight itching in region of clitoris; none in rest of vulva; no scratching.

CASE 6. Dispensary No. 4978. B. S., age 33. December 5, 1922. Pruritus for 3 months. Labia thickened, red, glazed; clitoris hypertrophied. Novocain injection. December 12, 1922. Condition was improved for 1 day, then worse than ever. Novocain injection, December 19, 1922. No itching for past 4 days. March 13, 1923. Has remained well for 3 months.

CASE 7. Dispensary No. 2932. A. S., age 57. April 27, 1922. Pruritus of long standing; labia infiltrated; vulva shows scratch marks. Novocain injection, May 6, 1922. Still some itching; novocain injection, May 11, 1922. Slight itching. Novocain injection. June 16, 1923. Itching has ceased. February 1, 1923. No further itching; vulva normal in appearance. Patient free of symptoms for 7 months following three injections.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D. ..... Managing Editor
ALLEN B. KANAVEL, M.D. ..... Associate Editor

DECEMBER, 1923

THE "ULCERATED TOOTH"

THE above term commonly designates an acute exacerbation of a previously quiescent peri-apical infection; this naturally and by common consent will call for the ministration of the dental surgeon. The attack may terminate or be terminated in one of several ways. After two days of suffering an abscess may perforate the bone causing the typical "gum boil" or less commonly it may burrow out alongside of the root of the tooth. The dentist may get drainage through a root canal, or an attempt may be made to abort the process by extracting the tooth. The latter treatment has the virtue of precluding future attacks and may be followed by quick recovery, by a more or less protracted or stormy convalescence, or occasionally by death from general sepsis.

It was an old teaching in dentistry that these teeth should not be pulled during the period of acute swelling, and there is often sound clinical observation back of these older teachings. With more modern and antiseptic technique, the general trend is to substitute active intervention for cultured conservatism and above all with the advent of the "exodontic" specialist, this older teaching lost precedence. The apparently more rational procedure of establishing free drainage and at the same time removing the supposed focus is apt to appeal more strongly to the new dentist. This procedure has been compared to the removal of an acutely diseased appendix but the simile is inapt because the appendix is the focus of the infection while the tooth is at this time but an inert plug. In their results the two procedures do not parallel and the observer standing on the side line, who takes occasion to sort over the wreckage, is apt to conclude that the average results do not justify the extra risk inherent to early extraction. In a certain small percentage of cases the reaction is accompanied by an increase of symptoms, or is followed by abscess formation, or extensive bone necrosis. In addition to this some young or apparently robust people will die from general sepsis following the extraction of an "ulcerated tooth" in the acute stage. On the other hand, except among enfeebled old people, death following the conservative plan is extremely rare and except among young children, cervical abscess or extensive bone necrosis is uncommon, where the tooth and the bone are spared the trauma of instrumentation in the acute stage of the infection.

This may seem difficult to explain but a study of the history of a typical case will at least furnish food for thought.

The "ulcerated tooth" is a fulmination of an infection that has been present for an indefinite time, possibly years, without giving more than mild or unidentified symptoms. Often the root canals of the damaged tooth were long ago sealed by the dentist and it is usually difficult to assign any logical cause

for the explosion. About the simplest explanation is the assumption that a disturbance of the balance between virulence and resistance has occurred which permits the hitherto imprisoned bacteria successfully to attack the confining barriers. This low resistance may be the reason why the trauma of an extraction may not be well tolerated at this particular time. This type of acute osteomyelitis should hold more than an academic interest for both the physician and the surgeon, either of whom must occasionally help a patient to choose between the man who offers immediate and permanent relief from a jumping toothache by a painless extraction under gas, and the old-fashioned dentist who prescribes quinine, phenacetin, the mustard foot bath, and the fig poultice, and who may attempt to establish drainage by the somewhat painful process of opening a root canal. The former may be the more brilliant procedure, but we can still give the conservative man our moral support with the assurance that his plan is the safer. Besides, the physician can always add sufficient morphine at least to ease the time of travail or possibly he may shorten it by an incision and a stripping up of the periosteum at the likely site of perforation.

At a later period when the balance between virulence and resistance has been re-established in the patient's favor, extraction of the tooth is not only safe but is better surgery than the most effective dental restoration.

This taboo against immediate extraction applies only to the period of acute local symptoms evidenced chiefly by swelling of the neighboring soft tissues and by the pain and tenderness that are characteristic of early osteomyelitis, not to the subacute stage in which discomfort, low fever, adenitis, malaise, rheumatism or joint infections etc., may evidence chronic infection. If, however, an extraction under these latter conditions is followed by a severe local flare up, then there may be good reason to go slow on repeating the insult.

V. P. Blair.

SUPRAPUBIC PROSTATECTOMY AS A ONE-STAGE OPERATION

THE operation of prostatectomy developed, in the early years of surgery of the bladder, through perineal or suprapubic drainage for urinary retention and the removal of vesical calculi. In the natural evolution, perineal and suprapubic methods were developed, and the latter is now most universally employed because of its direct attack, in cases of benign hypertrophy on the part of the gland involved, that is, the lateral and median lobes. Furthermore, associated lesions of the bladder, vesical calculi, diverticula, and, rarely, carcinomata are readily accessible through the suprapubic cystotomy.

The uniformly high mortality rate in the early years of prostatic surgery, a result of performing prostatectomy in the presence of chronic retention and renal insufficiency, led to the two-stage operation of suprapubic cystostomy preliminary to prostatectomy, which markedly reduced the mortality rate. However, the performance of a preliminary cystostomy in the presence of prolonged chronic retention and marked renal insufficiency is not without danger, and is accompanied by a definite mortality rate. Death from uræmia following preliminary suprapubic cystostomy is just as much a failure in the successful management of prostatic obstruction as death from the prostatectomy itself, and should be included in the mortality rate of the operation; for, whether death occurs following the first or second stage of the operation, the result is the same so far as the patient is concerned. Experience has shown that patients surviving the preliminary operation

and recovering from uræmia will pass through the second stage, or removal of the prostate, with an exceedingly low mortality rate. The diminished mortality rate of the two-stage operation has commended its use and led to its general adoption. However, it possesses the disadvantage of inaccuracy in the conduct of the second stage. A recent cystostomy forbids the wide exposure of a one-stage operation and necessitates a blind enucleation of the gland, which at times results in failure to remove all of the obstructing gland, or to control the bleeding accurately.

Recognition of the fact that all patients with prostatic obstruction are potentially, if not actually, uræmic, and the endeavor to improve the renal condition before prostatectomy have been primarily responsible for the recently diminished mortality rate. Recognizing that the preliminary suprapubic drainage produces improvement in the renal condition and general condition of the patient, the disadvantages of the second stage of the two-stage operation are overcome by instituting preliminary drainage of the bladder by a permanent urethral catheter instead of suprapubic cystostomy, which converts the procedure into a one-stage operation. The method of gradual decompression of the bladder in the presence of acute or chronic retention and uræmia, as described by von Zwallenberg and Bumpus, has largely obviated the necessity of suprapubic drainage and has avoided precipitate acute uræmia and death.

Permanent drainage by urethral catheter preliminary to the one-stage prostatectomy is successfully carried out in 76 per cent of the patients with benign prostatic hypertrophy. It is still advisable to remove the prostate subsequent to, rather than simultaneous with, the removal of vesical calculi and excision of diverticula or new-growths in the presence of renal insufficiency. Less than 10 per cent of patients are intolerant to the permanent urethral catheter. Permanent urethral catheter drainage of the bladder facilitates a single operation, and permits the application of the general principles of surgery to the operation of prostatectomy. In the past, the operation has been carried on in the dark by the use of the sense of touch only. The one-stage operation facilitates exposure and visualization of the entire procedure, insuring complete removal of the obstructing gland and irregular tags at bladder neck, and permits of accurate control of all bleeding.

The evolution of prostatic surgery has carried it well beyond the question of how quickly prostatectomy may be performed, but demands accurate application of the general principles of surgery to insure a low mortality rate and the best functional results. It is no longer to be expected that a patient's urine will contain blood for days after prostatectomy. In surgery of the prostate, the application of the principles of hæmostasis, applied elsewhere in the body, is equally effective, and the mortality rate bears a direct relationship to the loss of blood.

Sacral anæsthesia combined with abdominal infiltration affords complete relaxation for exposure and visualization of the operative field, and has displaced the use of general anæsthetics which, in the past, on account of their depressant effect on the kidneys, have sacrificed accuracy to technique for speed.

Uræmia, hæmorrhage, pneumonia, and general sepsis have been responsible for the high mortality rate in prostatic surgery in the past. The careful pre-operative preparation, and treatment of the actual or potential uræmia, the use of local anæsthetics, and accurately visualized conduct of the operation have decreased the mortality rate to a minimum, and insured excellent functional results.

VERNE C. HUNT.

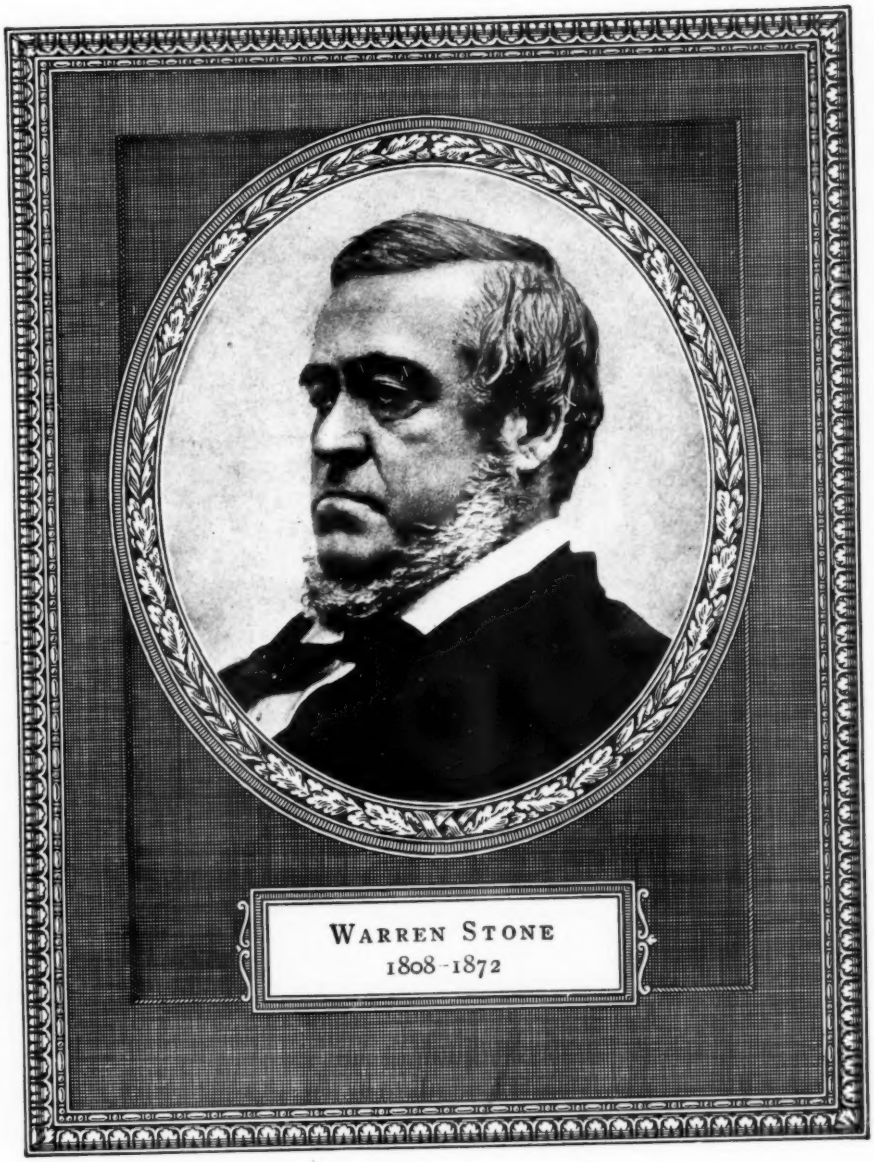
MASTER SURGEONS OF AMERICA

WARREN STONE

WARREN STONE was born at St. Albans, Vermont, February 3, 1808. His father, Peter Stone, was a farmer, and his mother, Jerusha Snow, from whom he inherited his physical development and the high intellectual and moral tone that spurred his ambition on to fields of noble enterprise beyond the limits of his narrow home. When he died, December 6, 1872, at the age of 64, this venerable mother survived him. To her he owed his remarkable physique and from her he derived, says one of his biographers, truth, honesty, philanthropy and self-reliance so conspicuous throughout his life.

These qualities, in spite of his meager opportunities for education, enabled him to reach a high degree of eminence as citizen and member of the medical profession.

His primary education was the scanty schooling of a fatherless boy in New England. His mother, however, supplemented these deficiencies, aiding him materially in his preparation for the study of medicine. He graduated from the Medical School of Pittsfield, Massachusetts, in 1831, and began the practice of medicine in Troy, New York. Here he attended the first cholera case brought to Troy by emigrants from Quebec and Montreal, fleeing to the states by way of Lake Champlain. Dr. Stone recognized the disease and attended the first victim. Thirty-five years later in a paper on cholera he wrote: "It so happened that my professional life and the cholera in this country commenced together." Fortunately, for New Orleans and the South, his career did not end with the cholera. This was but the prelude to his exciting experience with this disease on the cholera ship "Amelia," on which he embarked for New Orleans where he wished to settle and practice. The brig left New York with 108 passengers. Four days out a great storm necessitated the closing of the hatches to keep the vessel from sinking. When the storm abated Dr. Stone found twenty-five of the passengers in the second stage of cholera. The ship was beached off Folly Island, near Charleston, and the disease was carried to the island. The island belonged to Mr. Alexander Milne, who opened his house to the sick and destitute, generously furnishing them with supplies. Charleston quarantined the island but sent down physicians to look after them. Dr. Thomas Hunt, a native of Charleston and born in the same year as Dr. Stone, was put in charge and was ably assisted by young Stone.



WARREN STONE
1808-1872

Here they met for the first time and here was formed that friendship which continued during their lives. Another ship was chartered and Dr. Stone continued his journey to New Orleans where he arrived in December, 1833, with one picayune in his pocket, which he often said he preserved for the sake of a nucleus. In that year cholera had claimed six thousand victims in a population of fifty thousand, at a time when yellow fever was also prevalent. Through the kindness of one of the physicians, Dr. Stone was appointed at first to a subordinate position in the Charity Hospital. A few months later Dr. Hunt, his acquaintance and friend of Folly Island who had moved from Charleston to New Orleans, became house surgeon. Through his recommendation largely Dr. Stone became a year later assistant house surgeon, under Dr. Harrison, house surgeon on the resignation of Dr. Hunt, who had conceived the idea of founding a medical college in New Orleans. Dr. Hunt, Dr. Harrison, and Dr. Stone were all born in 1808. They all became practically and closely associated in the medical college. Medical education at this time was at a low ebb. Colleges were the product of private enterprise, organized as stock companies, composed of medical graduates. Their maintenance was dependent solely upon the number of medical students and the amount of their fees. Naturally standards had to be arranged to increase the number of students. The medical college of Louisiana, the germ of Tulane University, was just such a stock company, the outcome of Dr. Hunt's enthusiasm and energy. He delivered the introductory lecture in September, 1834. Although the requirements were low, the excellence of the faculty was largely instrumental in building up the attendance.

Dr. Stone was a huge, rugged man; his unusual height and weight were made more conspicuous by his massive head and his imposing features. He filled the position of demonstrator, lecturer and professor of anatomy during the first few years of the college, and in 1839 was made professor of surgery, which chair he held until his resignation early in the year of his death.

Dr. Stone was a very conservative surgeon, but by his sound common sense did much for surgery. In his lectures and conversation he displayed a faculty for anecdote and quotation. He was genial and frank, but not hilarious. He was not gifted with original wit or humor, but thoroughly appreciated it in others. He had a dislike for presumption and pretention, but was always generous in his estimate and treatment of others. He was himself modest and unpretending but not oblivious of his own merits. Dr. Stone's memory was unsurpassed and his reading extensive. In his lectures and addresses, he did not use memoranda, depending entirely upon his memory. He wrote little, so that, unfortunately, we have little record of his vast experience. He was, however, formidable in discussion, so vivid were his recollections, and so keen was his logical power of expression. He had the *tactus eruditus* remarkably well developed. He was editor of the *New Orleans Medical and Surgical Journal* from 1857 to 1868. A

few articles published in this journal comprised his contributions to medical literature, such as "Amputation of the Mammæ," "Ligature of the Femoral Artery," "Ligature of the Carotid, Ligature of the Vertebral, and the Treatment of Wounded Arteries." "Hernia and Obstruction of the Bowels," some clinical memoranda and notes from Dr. Stone's lectures, were published by his son, Dr. Warren Stone, Jr., just before his death.

No surgeon of the South ever enjoyed a more widespread reputation with the profession and the general public. As a man he was noted far and wide for his wisdom and by his patients he was affectionately regarded. He was very charitable but unostentatious. Professor S. D. Gross once called him "The Great Commoner of Medicine" and so great was his name in the city and so beloved was he by the people of New Orleans that when he died, December 5, 1872, the District Courts were adjourned as a mark of respect, the flags of shipping stood at half mast, and many of the stores were closed during the funeral.

Though a native of New England he sided with the state of his adoption when it seceded from the union and won the admiration of her people and the respect of her enemies.

FREDERICK W. PARHAM.

TRANSACTIONS OF SOCIETIES

CHICAGO GYNECOLOGICAL SOCIETY

REGULAR MEETING HELD APRIL 20, 1923, DR. HENRY F. LEWIS PRESIDING

PREMATURE SEPARATION OF PLACENTA

DR. WILLIAM C. DANFORTH: I wish to report a case of premature separation of the placenta which resembles closely one which Dr. Paddock reported at a previous meeting. The patient was a primipara, age 22, at term with a large child with unengaged head. She came to the hospital because of occasional pains. During the night sudden abdominal pain occurred followed by active external hæmorrhage. I was in the hospital at the time, saw her at once, and found a dilatation of one finger's breadth only and continuing active bleeding. Fetal heart tones were audible and strong. With no dilatation and unengaged head labor undoubtedly would have been long. Section was, therefore, done at once, the child being saved. The placenta was found partially detached. The value of immediate attention to obstetric emergency is well illustrated, as it enabled us to save the child, a rather infrequent result in cases of this type.

Dr. Arthur Curtis read a paper entitled "Management of Female Urinary Bladder after Operation and during Pregnancy: a Further Study of Residual Urine in Its Bearing on Urinary Tract Disturbance:

FRACTURE OF THE PELVIS DURING PREGNANCY

DR. CAREY CULBERTSON: I wish to make a short report of a case of fracture of the pelvis which occurred in the latter months of pregnancy without interruption of the pregnancy which was terminated by cæsarean section.

The patient was a young woman, 28 years of age, in her first pregnancy. Her last period occurred September 20, 1920, and the eighth May following, while motoring near Danville, Illinois, the automobile in which she was riding was overturned. She was pinned underneath the car, sustaining an injury of the hip and arm, a laceration of the scalp, and a fracture of the pelvis. She was brought into the hospital 8 hours after the accident with the arm and head in bandages. The scalp wound had been sutured with catgut. X-ray plates of the pelvis region showed a double fracture. The plate here reproduced shows an oblique fracture of the upper ramus of the right pelvic bone a transverse fracture of the lower ramus, and an oblique fracture through the body of the left pelvic bone with moderate separation of the symphysis pubis. Incidentally, this plate also shows the fetal head and other portions of the fetal skeleton, and reveals six lumbar vertebræ instead of five. There was no evidence of injury to the bladder. It was at this time that I was called in consultation and the patient was treated conservatively. At no time was there pain due to uterine contractions. Six weeks later, on the twenty-ninth of June, she was delivered by cæsarean section by Dr. A. M. Miller of Danville, to whom I am indebted for the details of this report. Labor came on spontaneously and with the first pain the membranes ruptured, whereupon the section was at once performed. The patient has made a normal convalescence and was discharged from the hospital July 15.

This case is of particular interest in showing extensive fracture of the pelvic bones, sustained approximately six weeks prior to term, without interference with the pregnancy in any way.

RUPTURE OF THE UTERUS

DR. DAVID S. HILLIS: I wish to report a case of ruptured uterus which was recently admitted to the Cook County Hospital. The patient entered the hospital on February 18 and went home on March 12. She was a II-para and had had no miscarriages. Fifteen months ago a cæsarean section of

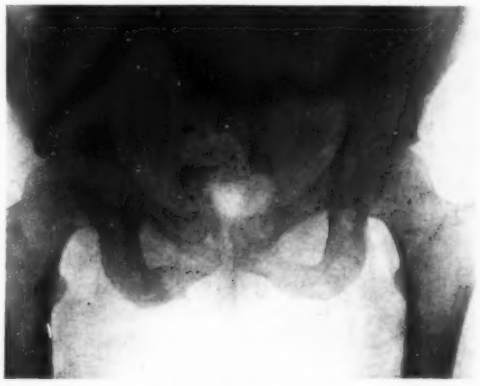


Fig. 1. Fracture of pelvis sustained in eighth month of pregnancy. (Case of Dr. Culbertson.)

the classical type was done at the Cook County Hospital. During the puerperium she had considerable temperature which was believed to be due to respiratory infection. She was discharged cured on the twelfth day with her baby. Her last menstruation was May 24, 1922, date of expected confinement March 1, 1923. The day before admission to the hospital the patient fell on the sidewalk but noticed nothing unusual until 24 hours later. While sitting at the breakfast table she was suddenly seized with a pain in the abdomen, started to walk to a couch, and fell to the floor on account of the severity of the pain. She managed to crawl to the couch and had another sharp pain which was so severe that she called a doctor. The doctor left some medicine, after which the patient felt better for a time, but soon thereafter became so sick she applied for admission to the County Hospital, 12 hours after the onset of the attack. On examination she was found to be in considerable shock, very pale, with systolic blood pressure of 55, diastolic questionable. The abdomen was somewhat soft throughout, with dullness in the flanks and a tympanitic area over the epigastrium. Under the old cæsarean scar was a soft mass which felt like the unruptured bags of water immediately under the abdominal wall. The fetal parts could be palpated with abnormal distinctness, but there was no mass to correspond to a ruptured and contracted uterus to be felt in the abdomen.

Vaginal examination revealed a cervix not large, and not dilated; no presenting part felt. Conjugata vera 7.5 centimeters. Her hæmoglobin was 80 per cent. Reds 4,250,000. Pulse not perceptible at wrist. Temperature 97.4°, respirations 26. She was given 800 cubic centimeters of intravenous salt solution and one-quarter grain of morphine. An immediate operation was done. The placenta was found lying immediately under the old scar in the anterior abdominal wall, maternal surface upward. The fetus was found lying among the intestines, entirely outside of the uterus. There was a small amount of free blood in the peritoneal cavity, showing that not much hæmorrhage had taken place and accounting for the fairly good condition of the patient. The uterus was removed on account of the extent of the tear in the anterior wall and because it was so firmly contracted that the edges could not be brought together and sutured without considerable difficulty.

The opening in the uterus included the entire length of the body and part of the fundus, and extended downward for about one-half inch toward the right in the lower uterine segment. Operation required 45 minutes and the patient left the hospital well on the twelfth day.

This case indicates that if the tear in the uterus is large enough so that it may expel all of the contents it may contract down and thus prevent fatal hæmorrhage. The scar resulting from a previous cæsarean section, which has gone through a febrile puerperium, is not to be trusted in a subsequent labor. This uterus ruptured spontaneously, in the early part of the ninth month.

VASA PRÆVIA AND PLACENTA PRÆVIA MARGINALIS

Dr. C. D. Hauch: This specimen is a placenta weighing 1300 grams, from a case of placenta prævia marginalis. There is also a velamentous insertion of the cord. The patient, a V-para, flowed last on August 15, 1922, but felt life November 1. In January a diagnosis of polyhydramnios was made. By April 1 the top of the fundus was 40 centimeters above the symphysis, but the position of the fetus could not be outlined. The patient's condition demanded induction of labor. When the membranes were ruptured the cord prolapsed and the breech presented in the right sacroposterior position. The cervix was easily dilated, the cord drawn upward, but there still remained at the cervical outlet a mass of large veins, later found to be a true vasa prævia. Rapid extraction was decided upon as the child was making respiratory efforts when the foot was delivered, and the low implantation of the placenta had not given rise to hæmorrhage. Delivery was accomplished without injury to the mother, but the child was asphyxiated. The placenta which was removed manually extended from cervix to fundus.

Dr. William R. Meeker, Rochester, Minnesota, read a paper (by invitation) entitled "Regional anæsthesia in Gynecology and Obstetrics." (See p. 816.)

THE TREATMENT OF CARDIOPATHS IN PREGNANCY AND LABOR

Dr. William C. Danforth read a paper on the management of cardiopaths in pregnancy and labor. (See p. 774.)

DISCUSSION

Dr. Rudolph W. Holmes: No one who has a custom of making a routine physical examination of all obstetric women can escape finding repeatedly, and rather frequently, cardiac lesions. The vast majority of such valvular cases pass through pregnancy and labor uneventfully. Ever since McDonald, in 1878, issued his volume on heart disease in the obstetric relationship, and made the complication an extremely grave one for the woman, all other writers have followed his lead with lugubrious deductions. Fellner illustrates this in his résumé of heart disease in the Vienna clinic. The whole trouble is that writers place the results of their grewsome findings from deductions of cardiopaths with broken compensation. In my own work I have seen no near disasters accompanying valvular lesions unless there be stories of attacks of broken compensation, antedating the pregnancies.

Some years ago a woman came to me with a statement that three physicians had demanded that she have an immediate therapeutic abortion for a

double mitral lesion. In view of the fact that she had not had a muscular disturbance of her heart since her initial attack some 10 years before I urged that she go through the pregnancy, acting when action was required. She had a perfectly normal, easy confinement with no cardiac disturbance. After her delivery I strongly urged the couple to see that conception never occurred again. But, a week ago she returned from New York for a second confinement due the middle of May. The day after seeing me in my office her heart broke, and the next day she went into labor, she notifying me only when labor had started: the labor lasted 3 hours, though I delivered her instrumentally when the head was crowning on account of the marked effects of the loss of compensation. She nearly died, but fortunately, she passed the crisis.

I believe the sum total of wear and tear on a cardiopath is as great following a cæsarean section as a properly conducted labor: the one advantage of a section is that it permits a coincident removal of the tubes. We may not question but that pregnancy and labor has its deleterious effects on a heart with a valvular lesion even though at the time no evident injury is produced. Later the heart muscle will show that it has been compromised. Rarely should a therapeutic abortion be done for a cardiopath, but pregnancy always should be looked upon with some apprehension is such women, and discountenanced if even slight periods of cardiac stress have manifested themselves. The problem of the cardiopath should be worked out by the internist and the obstetrician together.

Dr. Charles E. Paddock: One never knows how a heart which has been injured by disease will act with the strain of pregnancy or labor. Whatever the lesion I always want an internist to share the responsibility with me. I have had patients go through labor and pregnancy with serious lesions of the heart in safety, and again at the last moment I have had a comparatively simple heart lesion call for immediate interruption of the pregnancy. Associating myself, therefore, with an internist has undoubtedly been of great benefit not only to the patient but to me.

Generally speaking, whatever the lesion a patient should not be allowed to remain long in the second stage of labor whether the heart be compensating or not. Pregnancy should be interrupted where symptoms develop which shows circulatory disturbance. Generally these symptoms come in the latter month of pregnancy when the child is viable. The question then arises as to the best method of terminating the pregnancy. Both in the interest of mother and child, there is no doubt in my mind that the cæsarean operation is in the majority of such cases the operation of choice. Local anæsthesia can be used and the woman delivered with comparative comfort. This allows sterilization of the patient.

Dr. Carey Culbertson: I think that Dr. Danforth has emphasized adequately the importance of the functional capacity of the heart rather than the type of lesion. No one can tell—at least, I am sure I have never been able to prognosticate—what a heart that has a lesion is going to do whether compensated or decompensated, at the time of labor. We all know that a woman with a valvular heart lesion often can go through labor without help, but that is no reason why she should be allowed or expected to do so without help.

The last cardiopath who died under my care was also an eclamptic. Convulsions ceased after delivery, and the toxic condition was clearing up when, on the fourth day after delivery, the heart which up to that time was compensated, went suddenly to the bad and the patient died in a few hours.

I believe that if these hearts should be saved during pregnancy they should be saved in labor. A patient who lives on the second or third floor should not run up and down stairs during pregnancy, and she should not be allowed to bear down during labor in any case, whether the heart is compensated or not. She should be delivered by artificial aid in order to avoid the strain of bearing down. This was Webster's teaching, and I am sure is good teaching.

The feature of anæsthesia I have spoken of before in cases of this sort. I do not think that nitrous oxide gas is the proper anæsthetic in heart lesions whether the heart is compensated or not. I make this a rule to be followed not only in obstetrical but in gynecological cases as well.

Dr. Paddock's experience is exceptional and due in at least one instance, to good fortune, for one of his patients died under my care, when he was absent on vacation. This was one of the worst cases of decompensated heart that I ever saw.

Dr. Danforth (closing): I wish to thank the gentlemen who were good enough to discuss my paper. I think the point as to the functional capacity of the heart, as Dr. Gilbert emphasized, is by all means the most important single thing concerning the pregnant woman's heart, and the fact that she has murmur is of secondary importance. The work the heart is called upon to do is of primary importance.

The influence of infection of which Dr. Gilbert speaks is important. While I did not go into that in the paper, all infections present in a pregnant woman deserve unusual attention, especially infections about the teeth, tonsils, and sinuses.

As to cæsarean section in heart cases no doubt many do come out well. However, as a routine thing, I would maintain the ground which I took in the paper, that is, they are more safely delivered by the vaginal route.

Dr. Culbertson's emphasis upon removal of the strain of the second stage of labor in the cardiac case is important even in a woman with a minimal decompensation, and where marked decompensation is present, without question the child should be extracted operatively.

AMERICAN COLLEGE OF SURGEONS

STATE AND PROVINCIAL MEETINGS OF THE CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

MANITOBA; ALBERTA AND SASKATCHEWAN; MONTANA AND NORTH DAKOTA; OREGON AND IDAHO; WASHINGTON AND BRITISH COLUMBIA; AND UTAH, COLORADO, WYOMING, AND ARIZONA.

THE autumn group of sectional meetings of the American College of Surgeons for 1923 was completed with the Denver meeting on October 4 and 5, last. Without doubt the six sectional meetings in this group were, on an average, the most successful and enthusiastic which the College has had.

MANITOBA

The Manitoba Sectional Meeting was held in Winnipeg on the 10th and 11th of September. The headquarters were at the Fort Garry Hotel, and clinics were conducted at the Winnipeg General and St. Boniface Hospitals.

The visiting speakers were Dr. Charles H. Mayo, Rochester, Minnesota; Dr. James T. Case, Battle Creek Sanatorium, Battle Creek, Michigan; Dr. Malcolm T. MacEachern, Chicago; Rev. C. B. Moulinier, S.J., Milwaukee, Wisconsin; and Dr. Allan Craig, Chicago.

The hospital meeting was held in the Fort Garry Hotel on the first afternoon and drew an attendance of over three hundred. The public meeting, which had an attendance of sixteen hundred, was held on the evening of the first day in the Concert Auditorium of the hotel. Long before the time for the opening of the meeting this auditorium was packed and there was standing room only. It was necessary on this account to open the large Ball Room and this was also filled to capacity. Every speaker on the program was required to speak twice, and even with these two auditoriums available some four or five hundred were unable to gain admission. During the morning of the first day Dr. Charles H. Mayo gave a clinical talk at the University Medical School, and on the morning of the second day Dr. James T. Case also gave a clinical talk and demonstration at St. Boniface Hospital. On both of these occasions there was a very large attendance. The scientific meeting on the second afternoon was well attended. The clinics were carefully prepared and systematically conducted. In fact, every detail in connection with the meetings was thoroughly planned and executed by the energetic local committee, to whom our thanks are due.

ALBERTA–SASKATCHEWAN

The Alberta and Saskatchewan Sectional Meeting was held in Edmonton on September 14 and 15. Headquarters were at the MacDonald Hotel. The arrangements for these meetings were in the hands of the local Fellows who were assisted in the publicity by Mr. John Blue, secretary of the Chamber of Commerce. The organization of these meetings was everything which could be desired.

The hospital meeting, held on the afternoon of the first day at the MacDonald Hotel, drew an attendance of approximately two hundred and fifty. The public meeting was held in the University Convocational Hall, which was packed to the limit long before the opening of the meeting. It was necessary to use as well one of the large lecture rooms. This was also filled to capacity and many were turned away. Here, again, every speaker was required to address two audiences. Lieutenant Governor Brett occupied the chair at the evening meeting and did everything possible to assist in making the various sessions successful.

The visiting speakers at Edmonton were Dr. James T. Case, Battle Creek Sanatorium, Battle Creek, Michigan; Dr. Carl A. Hedblom, Rochester, Minnesota; Dr. James B. Eagleson, Seattle, Washington; Dr. H. M. Tory, president of the University of Alberta, Edmonton, Alberta; Dr. Malcolm T. MacEachern, Chicago; Rev. C. B. Moulinier, S.J., Milwaukee; and Dr. Allan Craig, Chicago.

Clinics and clinical demonstrations were held at the local hospitals and were all well attended. The scientific session on the second afternoon held at the MacDonald Hotel, was well attended and was very interesting and instructive. The thanks of the College are due to the local com-

mittee and Fellows of the College in Edmonton for their work in making the meeting successful.

On the way south from Edmonton to Great Falls, the visiting speakers stopped at Calgary, where they were entertained by the local Fellows of the College and other members of the profession and took part in a scientific session at the Holy Cross Hospital.

MONTANA–NORTH DAKOTA

The Montana and North Dakota Sectional Meeting was held at Great Falls, September 18 and 19. Headquarters and registration rooms were at the Rainbow Hotel. The various sessions were conducted in the Grand Theater.

The hospital meeting on the afternoon of the first day was well attended. The public meeting drew an audience of eleven hundred.

The following were the visiting speakers: Dr. James T. Case, Battle Creek Sanatorium, Battle Creek, Michigan; Dr. Carl Hedblom, Rochester, Minnesota; Dr. James B. Eagleson, Seattle, Washington; Dr. Malcolm T. MacEachern, Chicago; Rev. C. B. Moulinier, S.J., Milwaukee; and Dr. Allan Craig, Chicago.

During the program a very delightful violin solo was rendered by Mr. Henry Dotseth of Great Falls, Montana. The address of welcome was given by Mayor H. B. Mitchell. Following the program a moving picture, "The Reward of Courage," was shown. Clinics and clinical demonstrations were given at all the city hospitals and were well attended. The scientific meeting which was held on the afternoon of the second day drew an attendance of one hundred and twenty-five.

The thanks of the College are due to the local Fellows and the members of the Committee who successfully carried on the arrangements for the various sessions.

OREGON–IDAHO

The Oregon and Idaho Sectional Meeting was held in Portland, September 24 and 25. Headquarters and registration rooms were at the Portland Hotel.

The hospital meeting on the first afternoon drew an attendance of three hundred and fifty and the program was enthusiastically received.

The visiting speakers were Dr. James T. Case, Battle Creek Sanatorium, Battle Creek, Michigan; Dr. Dennis Crile, Chicago; Rev. Mark A. Matthew, Seattle, Washington; Rev. C. B. Moulinier, S.J., Milwaukee; Dr. Malcolm T. MacEachern, Chicago; and Dr. Allan Craig, Chicago.

The public meeting was held in the City Auditorium and was the largest which the College has ever had. Although the weather was very unfavorable, the attendance numbered over five thousand. This meeting without doubt broke all the records for public meetings in connection with the sectional meetings of the American College of Surgeons. Too much credit cannot be given to the local committee and especially to those who conducted the publicity.

Clinics were held in local hospitals and the scientific meeting on the second afternoon had an attendance of two hundred. Altogether the Portland Sectional Meeting was one of the most successful which the College has had.

WASHINGTON–BRITISH COLUMBIA

The Washington and British Columbia Sectional Meeting was held at Victoria, B.C., on September 28 and 29. Headquarters and registration rooms were at the Empress Hotel.

The hospital meeting on the first afternoon was crowded. The public meeting was held in the Ball Room of the Empress Hotel. Long before the time for the meeting to begin the auditorium was crowded and there was standing room only. Many were turned away.

The visiting speakers were Dr. James T. Case, Battle Creek Sanatorium, Battle Creek, Michigan; Dr. R. C. Coffey, Portland, Oregon; Dr. Malcolm T. MacEachern, Chicago; Rev. C. B. Moulinier, S.J., Milwaukee; and Dr. Allan Craig, Chicago. The Lieutenant Governor of the proince delivered the address of welcome.

Following the usual program, which was one of the most interesting and enthusiastic of the western group, a moving picture film, "The Reward of Courage," was shown.

Clinics and clinical demonstrations were conducted at the city hospitals on both days. The scientific meeting held on the second afternoon was well attended. Everyone was enthusiastic in the praise of the meetings held in Victoria, and our sincere thanks and appreciation are due to the energetic efforts of the local committee who made them so successful.

UTAH–COLORADO–WYOMING–ARIZONA

The Utah, Colorado, Wyoming, and Arizona Sectional Meeting was held in Denver on October 4 and 5. Headquarters and registration rooms were at the Brown Palace Hotel.

The visiting speakers were Dr. Major G. Seelig, St. Louis, Missouri; Dr. James T. Case, Battle Creek Sanatorium, Battle Creek, Michigan; Dr. Malcolm T. MacEachern, Chicago;

Rev. C. B. Moulinier, S.J., Milwaukee; and Dr. Allan Craig, Chicago.

The hospital meeting had an attendance of three hundred and twenty-five. The public meeting was held in the City Auditorium. Mr. Tyson Dines, of Denver, presided.

Besides the visiting speakers, Rev. Dean D. H. Browne, Rev. Father Hugh L. McMenamin, and Rabbi W. S. Friedman, of Denver, delivered short and interesting addresses. The scientific meeting was held at the Brown Palace Hotel on the second afternoon. As an addition to the surgical program of this meeting, Dr. Finney, of Colorado Springs, gave interesting and instructive addresses on the use of insulin. Everyone was convinced that it was a decided benefit to have a physician on the program and that the custom should frequently be followed up.

Clinics and clinical demonstrations were held in local hospitals.

The thanks of the College are due to the local committee for their energetic efforts.